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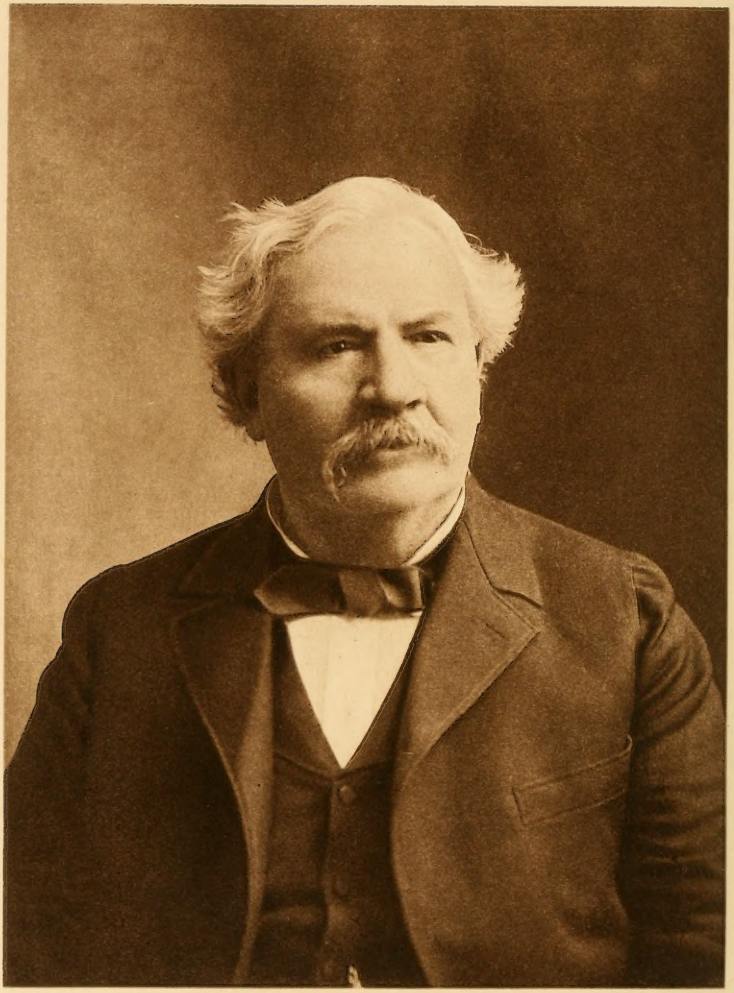

C. A. Goessmann

CHARLES ANTHONY GOESSMANN

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No 1.

TEACHERS SHALL SHINE
AS THE BRIGHTNESS OF THE FIRMAMENT;
AND THEY THAT LEAD MANY TO TRUTH
AS THE STARS FOR EVER AND EVER

(*From the inscription on Fichte's monument in Berlin*)

Committee of Publication

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CHARLES WELLINGTON

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CHARLES ANTHONY GOESSMANN

CHAPTER I

DESCENT AND EARLY MANHOOD

1827–1857

Charles Anthony Goessmann, the eminent chemist, the broad-minded student of Nature, the lovable man, ended his life of unceasing and fruitful work on the 1st of September 1910, in the eighty-fourth year of his age.

He was one of the notable group of European scientists who, some three generations ago, found a home in the United States. Conspicuous among these were Engelmann the botanist, Agassiz the naturalist, Pourtalès the zoologist, Guyot the geologist and physiographer, Lesquereux the palaeobotanist and bryologist, Genth the mineralogist, and Goessmann the chemist.

The Goessmanns, it is said, came originally from Spain, where the name was spelled Guzman. About 1520 they passed into Germany, in the train of the Emperor Charles V, and became seated in Hesse. They were land-owners from the first, and not a few entered the Church and the army. The branch from which Dr. Goessmann sprang had long been settled in the ancient town of Fulda, the seat of a famous monastery founded by Boniface, the apostle of Germany, and selected by him as the place of his burial. Joseph

Goessmann of Fulda and later of Fritzlar, grandfather of Charles Anthony, was a judge of the higher court of Electoral Hesse, lay administrator of the diocese of Fulda, and a man of much influence in his day. He was on intimate terms of friendship with Georg Friedrich Heinrich, reigning Prince of Waldeck-Pyrmont, great-grandfather of the present Queen of Holland, and the little summer-house in his garden at Fritzlar, where the Prince and he played their weekly game of chess and drank their coffee, may still be seen.

The wife of Judge Goessmann was Fräulein Kaiser, a woman of rare mental vigour and brilliancy. Of her three brothers, one established the chair of social law (now political economy) at the University of Graz; another became vicar-general of the diocese of Fulda; and a third was an officer in the imperial army. The latter, wounded at the battle of Wagram, was raised by the Emperor to honorary life-membership in the Noble Imperial Guard of Austria as a reward for singular bravery and courage. The three daughters of Judge Goessmann were known to their contemporaries as the 'three beautiful sisters.' Two of them became ladies-in-waiting at the court of the Electoral Princess of Hesse-Cassel, and married respectively Baron von Mumm and Baron von Borke, officers in the German army.

Heinrich Goessmann, son of Joseph and father of Charles Anthony, was born 30 March 1799, at Fritzlar, Hesse-Cassel, and passed much of his life there. In his youth, with his elder brother Philip, he served as a volunteer in the war against Napoleon in 1815. A

graduate in medicine of the University of Marburg in 1820, he numbered among his fellow-students Friedrich Wöhler, the celebrated chemist and discoverer of organic chemical synthesis,[1] with whom he formed a warm and lasting friendship.

From Marburg he proceeded to Würzburg, where two years were spent at the University and hospital, and where he enjoyed the instruction of the *Naturphilosoph* Ignatius Döllinger, the founder of embryology, teacher of Agassiz and von Baer, and father of Dr. Johann von Döllinger of Munich, the leader of the Old Catholics. Dr. Goessmann subsequently became *Kreisphysikus* or district physician and health officer in Hesse-Cassel, and in recognition of his services was made a medical councillor by Emperor William I. In addition to this distinction the University of Würzburg conferred upon him the honorary degree of Doctor of Medicine. He died at Fritzlar, 22 February 1880.

The life and work of Charles Anthony Goessmann falls naturally into three well-defined periods. The first period ended in 1857 with his departure from Göttingen; the second, and shortest, terminated in 1868 with the call to Amherst; and the third comprised his two-score years of service here as Professor in the College and Director of Research. During the first period he made his most important researches and discoveries in theoretical chemistry, organic and analytic. The second period was marked by investigations

[1] 'The first synthesis of an organic compound, that of *urea*, achieved more than a quarter of a century ago by the illustrious Wöhler, will, for simplicity and elegance of the successive reactions employed, ever remain the model of synthetical processes.' — A. W. Hofmann in 1863.

in technical and industrial chemistry, particularly in its relations to the sugar and salt industries. The third and last period was devoted almost entirely to agricultural chemistry, a branch of chemical science in which he was a leader in this country.

Karl Anton Goessmann, third and youngest son of the four children of Geheimer Medizinalrath Dr. Heinrich Goessmann and Helena Henslinger-Boediger his wife, was born on the 13th of June 1827, at Naumburg, in the electorate of Hesse-Cassel. Carefully nurtured, he received his early training, first in the schools of his native place and later at the Latin School of Fritzlar, whither his father had removed while the son was still a lad of eight or nine, and which henceforth was the home of his youth and early manhood. There he passed through the curriculum, his quiet bearing and studious habits winning him the commendation and respect of his teachers. Fond of flowers and pets as a child, he early developed a taste for the natural sciences, and his spare hours and holidays were largely spent roaming the fields, woods, and hills in search of plants, minerals, and other objects of interest. He also delighted especially in books of travel and adventure. His education owed more perhaps to his home circle than to the school. His mother, an excellent woman of great piety, devoted herself to the culture of her four children, and had she lived until Anton's manhood, he might have entered the Church — thus following the example of his maternal uncle, who was attached to the Dom of Fritzlar, where the young Goessmann often served as altar-boy. The 'priest-uncle,' as he

FRITZLAR
From the West

was fondly called, was the instructor, mentor, companion, and idol of his kinsfolk.

On leaving school young Goessmann, like Davy, Liebig, Heinrich Rose, and the French chemist Pelouze, first became interested in pharmacy. He pursued his studies with a kinsman at Gudensberg near Cassel, to whom he had been apprenticed, and in 1846 passed the state examination required to qualify him as an assistant in pharmacy. The next four years were passed as an apothecary's assistant at Göttingen, Mainz, and Fulda, Goessmann devoting his spare moments to the pursuit of his favourite studies, chemistry, botany, and geology. Inheriting, however, a love of science and wishing to perfect himself yet further in his vocation, he entered the University of Göttingen at Easter, 27 April 1850, matriculating in the philosophical faculty as a student of pharmacy. It was natural that in seeking a university he should turn to Göttingen, where three years earlier he had been assistant to Julius Post, the University apothecary, and where his father's friend and fellow-student at Marburg, Friedrich Wöhler, then at the height of his fame, filled the chair of chemistry.

The following letter from Wöhler to *Kreisphysikus* Dr. Goessmann has fortunately been preserved: —

Göttingen, 12 *April* 1850.

Most esteemed Sir and Friend, —

Your lines have recalled to me most vividly the scenes of my first university year and my associations with you in old Marburg. Although more than 30

years have passed, I can see you so plainly that I could make a sketch of you. I need not assure you that I shall take care of your son in the best possible manner. I shall reserve for him the first place that may be vacant. The lectures and laboratory work are set to begin as early as the 15th of the month. It can be foreseen, however, that as usual only a few students will be present. Therefore, I, as well as most of my colleagues, shall not commence until Thursday the 18th of the month.

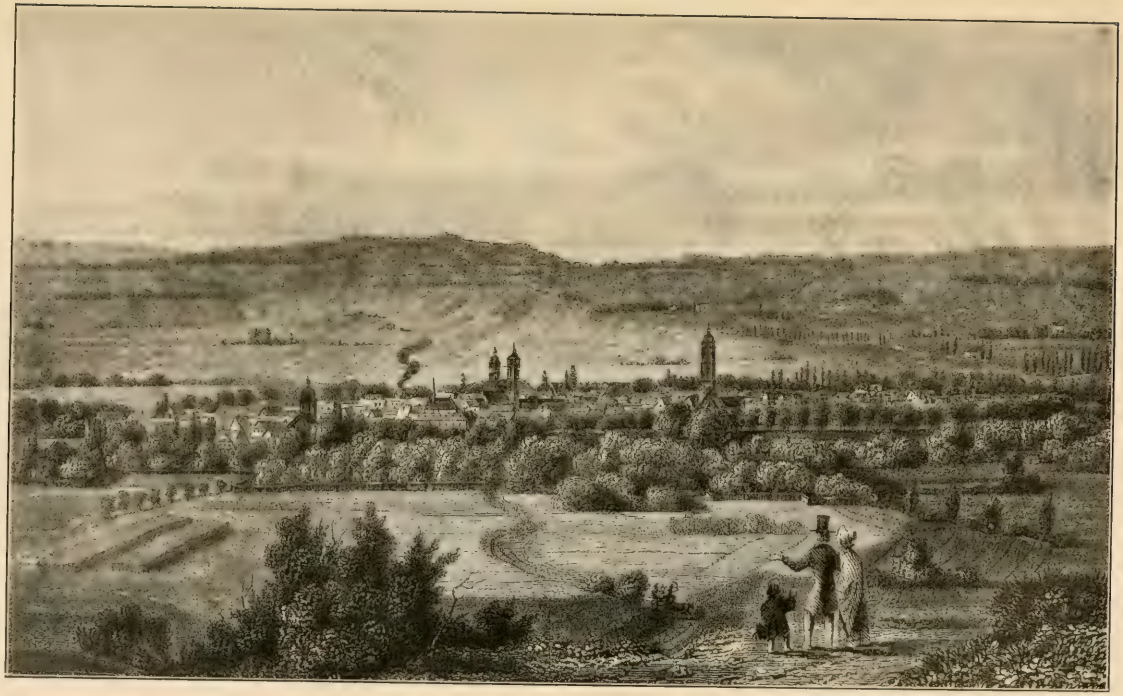
With great respect,

Your most obedient,

WÖHLER.

Here, during the next five semesters, he heard Wöhler, Wiggers, and Staedeler in chemistry, Bartling and Lantzius-Beninga in botany, Weber, the renowned physicist and revolutionist, in physics, Sartorius von Waltershausen in geology and mineralogy, Hausmann in technology, and Bohtz in the history of German literature. Thus was laid a broad and solid foundation for his future life-work.

At the close of the summer semester of 1851 Goessmann, it seems, had fully determined to leave Göttingen and follow the calling of a pharmacist. With that purpose in view he went to take leave of his teacher. Wöhler, discerning in his young friend those endowments and aptitudes of mind which promised success in the field of science, pointed out the difference between practical pharmacy and scientific chemistry, and urged upon him the expediency of abandoning the



GÖTTINGEN
From the East

former and of devoting himself to science. Happily, the advice was followed, and Goessmann decided to devote himself henceforth to chemistry. Soon after this he became chemical assistant to Professor Staedeler, who was then lecturing on physiological chemistry.

In March 1852 he passed the examination in pharmacy before the Electoral Medical College of Hesse-Cassel, and in June was appointed by Wöhler second assistant in analytical and practical chemistry in the Chemical Laboratory. During the temporary absence of Wöhler in Switzerland, whither he had gone in search of health, Goessmann taught his class in pharmaceutical chemistry. On his return Wöhler presented him with a handsome Swiss watch, which he carried for more than half a century.

In the autumn of 1852, during the *dekanat* of Geheimer Hofrath Ritter, Goessmann presented a dissertation *Ueber die Bestandtheile der Canthariden.* This was his first scientific paper and stamped its author as an original investigator of marked ability. In December, 'after passing,' says Wöhler, 'a most excellent examination,' he took his degree as Doctor of Philosophy.

Two years later, in 1854, appeared his *Habilitationsschrift, Verwandlung des Thialdins in Leucin* and *Beitrag zur Kenntniss des Leucins.* The results of this classic research on the constitution and production of leucin were at once communicated by Wöhler to Jean-Baptiste Dumas, Perpetual Secretary of the French Academy of Sciences, and published by him in the *Comptes rendus.* This important contribution to knowl-

edge also obtained him the distinction of associate membership in the Physico-Medical Society of the University of Erlangen.[1]

In February of 1855 he was appointed *Privatdocent* in the philosophical faculty, with permission to lecture in all branches of chemistry and pharmacy, and soon thereafter, on the promotion of his friend and colleague, Heinrich Limpricht, to a professorship, he succeeded him as first assistant in the Chemical Institute. From 1852 to 1857 Goessmann lectured on organic chemistry, on selected subjects in technical chemistry, had charge of the instruction in organic and inorganic analysis, and taught pharmacy to the medical students.

'He acted as my assistant in the laboratory,' writes Wöhler in 1857, 'and in this capacity he has served for five years to my utmost satisfaction, and has aided me most efficiently through his excellent knowledge and his indefatigable zeal in teaching practical chemistry.' From Professor Chandler we learn that Wöhler entrusted to Goessmann his most advanced laboratory students.

It was during this period that he made his most important researches and discoveries in organic and analytic chemistry. The results of these various investigations — some twenty-four in all — first appeared in Liebig's *Annalen*,[2] and established his reputation as a careful, skilful, and productive investigator.

In September 1854 the yearly meeting of the German

[1] Physikalisch-medicinische Societät zu Erlangen.

[2] Abstracts of these papers were published in the *Annales de Chimie et de Physique*, by Charles Adolphe Wurtz, the eminent French chemist.

Naturalists and Physicians was held at Göttingen,[1] and Goessmann read a paper, entitled *Ueber Leucin und Essigsäure-Aldehyd.* Two years later (16–24 September 1856) he attended the meeting at Vienna, where he saw many noted men of science, including Anton Schrötter, professor of chemistry in the Royal and Imperial Polytechnical Institute, perpetual secretary of the Academy of Sciences, and noted for his researches on phosphorus; Baron von Reichenbach, the technical chemist and discoverer of paraffin and creosote; Wilhelm Haidinger, the mineralogist and physicist, the discoverer of 'Haidinger's brushes,' and director of the Imperial Geological Institute of Austria; Leydolt, the mineralogist; von Martius, the celebrated Brazilian traveller and botanist; Franz von Kobell, the mineralogist and poet; Vogel, the agricultural chemist; Schafhäutl, the mineralogist and technologist; and Redtenbacher, the mechanician and director of the Polytechnic School at Karlsruhe.

During the years 1855 and 1856 Johann Lukas Schönlein, the eminent pathologist and physician to Frederick William IV, and the founder of exact modern clinical methods in Germany, had endeavoured to establish at the Royal Charité Hospital in Berlin a laboratory for research in physiological and pathological chemistry, and Goessmann was offered the directorship. Had this project succeeded, it would have been very gratifying to him, as he wished to devote himself to animal chemistry — a field of inquiry

[1] The yearly gatherings of the *Deutsche Naturforscher und Aerzte* were instituted by Lorenz Oken in 1822, the first meeting being held at Leipzig.

in which he had already achieved notable success. Owing, however, to the opposition of Eilhard Mitscherlich, to whom the matter was referred by the Prussian Ministry of Public Worship and Instruction, the project was abandoned.

As already mentioned, Goessmann's most important researches in the field of pure chemistry were conducted in the laboratory at Göttingen in the years 1852 to 1857 — years which were among the most active, fruitful, and enjoyable of his whole life. The free and cordial way in which he worked in conjunction with his pupils and others is partly seen in the various names which are associated with his in authorship.

His earliest investigation of which there is any published record, and with which his active scientific career may be said to begin, was upon the composition of *Cantharis vesicatoria*, and the results of this research, as already noted, appeared first in the dissertation for his doctorate.[1] He found that the fat of cantharidin consists of stearin, palmitin, and olein in the form of acid glycerides of margaric and oleic acids. At the suggestion of Professor Heintz he attempted the resolution of margaric acid by fractional precipitation into stearic and palmitic acids, and succeeded in separating the latter acid. In 1854 he discovered in the oil of the ground-nut (*Arachis hypogaea*) a new acid with the formula $C_{20}H_{40}O_2$, subsequently confirmed by Berthe-

[1] The brief outline of Goessmann's work in the Göttingen Laboratory here given does not conform in all respects to the chemistry of the present. Nevertheless, as it was revised by Goessmann himself, though many years ago, and received his approval, the editors decided to print it unchanged.

WÖHLER'S LABORATORY IN GOESSMANN'S TIME

lot, to which he gave the name arachic (or arachidic) acid. He next investigated the cocoa-nut oil, and found it to consist, not only of stearin and olein, as earlier pointed out by Boussingault and Stenhouse, but also of palmitin, the first mentioned in such predominating proportion that it was considered one of the best materials for the preparation of pure stearic acid.

In 1854 he published the results of his memorable research on the conversion of thialdin into leucin. In this research was verified the relation supposed to exist by M. Cahours between thialdin and leucin. The former, $C_6H_{13}NS_2$, he converted into leucin, $C_6H_{13}NO_2$, by treatment with oxide of silver and water at 212° Fahr. These results were at once communicated by Wöhler to Jean-Baptiste Dumas, Perpetual Secretary of the French Academy of Sciences, and appeared in the *Comptes rendus* the same year. It is interesting to recall that in the years 1853 to 1856 (almost simultaneously therefore) Frerichs at Breslau and Virchow at Würzburg were conducting investigations on the occurrence and separation of leucin and tyrosin in the animal organism, especially in the human liver.

Soon after this he investigated the compounds of leucin. He showed that leucin might be considered the amide of a compound acid consisting of valeral (aldehyde of valeric acid) and formic acid, a view subsequently confirmed by his colleague Limpricht. He showed, moreover, that leucin forms salts with oxide of copper and with peroxide of mercury; and that with oxide of lead two series of salts are formed, one insoluble and the other soluble. He also prepared leucic acid

from leucin by the same process which served him for the preparation of benzoglycolic acid from hippuric acid. After distillation he recognized as products of decomposition hydrocyanic and valeric (or valerianic) acids, ammonia and valero-nitrile. Previously he had obtained a solution which evolved the odour of chloride of cyanogen.

By a new method he obtained ethylamine from bisulphite of aldehyde-ammonia by distillation with calcium hydroxide. From the oil of bitter almonds (benzoic aldehyde) he collected amarine and lophine. He showed that lophine is formed when bisulphite of ammonia and oil of bitter almonds are heated together with dry calcium hydroxide. He and Atkinson likewise established the formula of lophine, $C_{21}H_{17}N_2$, — which differs very little from that adopted by Fownes, one of the original discoverers of this base, — and also showed that the pyrobenzoline of Fownes and the lophine of Laurent are identical.

In 1855 Goessmann and Scheven, in a subsequent investigation of the ground-nut oil, discovered a new member of the oleic acid series with the formula $C_{16}H_{30}O_2$, which they named hypogaeic acid. Goessmann and Caldwell showed that hypogaeic acid in contact with nitrous acid is converted into the isomeric compound, gaeidic acid. By dry distillation of hypogaeic acid Goessmann obtained ordinary sebacic acid. He also found palmitic acid present in the ground-nut oil. In his investigations on the combinations of arachic acid he prepared arachin by heating equal parts of arachic acid and glycerin in a sealed glass tube.

He obtained from the oil of cassia a new base, which he named triphenylamine, by heating the bisulphite of the ammoniacal cinnamic aldehyde with calcium hydroxide; and obtained tricaproylamine by a similar mode from caproyl aldehyde. He prepared coumarin from the Tonka bean, discovered a profitable way of separating styracin, and determined the composition of huanokine, a new base of Peruvian bark, $C_{20}H_{12}NO$, and found that it is isomeric with cinchonine. He investigated the action of zinc chloride on hippuric acid, and showed that when chlorine is passed into a solution of hippuric acid in rather dilute potash, nitrogen is evolved and benzoglycolic acid produced.

He obtained crystallized sulphocyanide of silver by the action of oxide of silver upon sulphocyanide of ammonium. Experiments on the action of oxide of silver upon sulphocyanide of ammonium gave occasion to the observation of the following very beautiful mode of formation of sulphocyanide of silver. If freshly precipitated oxide of silver be digested at a gentle heat with a solution of sulphocyanide of ammonium, a continual evolution of ammonia takes place, while oxide of silver is dissolved; and thus a compound of the sulphocyanides of silver and ammonium is formed, together with unchanged sulphocyanide of ammonium, the process affording a beautiful example of rapid formation of crystals. He found manganate of potassium a suitable substance for decolourizing organic bodies, and employed it in purifying uric, hippuric, and cyanuric acids, with great success. In 1857 he made repeated experiments with the view of obtaining by the

action of iodide of ethyl on tungstate of silver a compound of oxide of ethyl and tungstic acid. In this he did not succeed, but obtained iodide of silver, free tungstic acid, and oxide of ethyl. He showed that aniline is obtained when nitrobenzene is treated with caustic soda and arsenic trioxide — an investigation completed by Wöhler.

The year 1857 saw the completion of Goessmann's researches in the field of pure chemistry, and with it concluded the period of his most important discoveries. He soon attained, however, a leading place among technical chemists in the country of his adoption, and his advice was often sought on important questions. His attention was thus turned from purely scientific subjects to matters of more practical interest.

While a teacher at Göttingen he numbered among his American pupils and friends Caldwell of Cornell, Chandler of Columbia, Clark of Amherst, Garrigues of Michigan, Hungerford of Vermont, Joy of Union, Mallet of Virginia, Marsh of Illinois, Nason of Rensselaer, Pugh of Pennsylvania, and Weyman of Pittsburgh. Anton Geuther, afterwards called to Jena, was likewise a pupil of his and his immediate successor at Göttingen. The testimonials he received bear witness to the esteem in which he was held by his fellow workers and students. One of the most gratifying was a beautiful balance from his American students inscribed with their names.[1] At his departure from Göttingen his pupils presented him with a silver lov-

[1] The plate bears the following inscription: 'Presented to Dr. Goessmann by J. Dean, C. Chandler, E. Pugh, G. C. Caldwell, E. P. Eastwick, J. H. Eastwick, J. F. Magee, D. K. Tuttle, J. D. Hague, H. B. Nason.'

WÖHLER AND HIS ADVANCED STUDENTS, 1856

Goessmann at Wöhler's right

ing-cup, bearing the following inscription: *Ihrem verehrten Lehrer Dr. A. Goessmann die Practikanten des Chemischen Laboratoriums Göttingen 26ten März 1857.* Wöhler, his lifelong friend, gave him, amongst other tokens of regard, the portfolio used by Berzelius and himself for carrying notes and manuscripts during their geological and mineralogical tour through Sweden and Norway in 1824.

On 1 July 1824, Friedrich Wöhler and Christian Retzius set out for Skimskatteberg, the estate of Hisinger the chemist, where they found Berzelius awaiting them. There they spent a week, making short excursions in the neighbourhood with Berzelius and Hisinger. In the middle of July they journeyed to Helsingborg to meet the Brongniarts — Alexandre, the chemist and mineralogist, and his son Adolphe, the botanist. Here they found Baron Wrede the physicist, Oersted the founder of the science of electromagnetism, and Sir Humphry Davy the natural philosopher. At Lund they were welcomed by Nilsson the naturalist, and Agardh the botanist, and at Christiania by Hansteen the mathematician and astronomer, Esmark the mineralogist, and Steffens the *Naturphilosoph.* After an absence of two months, the party — which had included Berzelius, the Brongniarts, and Wöhler — returned to Stockholm. It does not appear, as Goessmann supposed, that Arfvedson, the mineralogist, was one of the party, though earlier the latter made a short journey to the island of Utö, in the Baltic, in company with Berzelius, Hisinger, C. Retzius, and Wöhler.

In April 1857, notwithstanding the prospect of further advancement, Goessmann left Göttingen. He was led to this step, partly because of an urgent invitation from the Eastwick Brothers of Philadelphia, former pupils of his in technical chemistry, to visit America and assume the chemical direction of an extensive sugar refinery, but chiefly because it was in accord with the advice of his revered teacher, which was 'to see something of the world and study the great industries.' 'Unfortunately, I am to lose him,' wrote Wöhler to Liebig at this time, 'for five years my assistant and known to you through his works.' [1]

He obtained from the University *Curatorium* a three years' leave of absence, for the purpose of studying the chemical industries of France, England and the United States. At his departure he was informed by the authorities that whenever within the three years he chose to return, he should be promoted to a professorship. That he fully expected to return to Germany there seems little doubt. It was not until some time after he had entered upon his work at Syracuse that he definitely resolved to remain in America.

The next few weeks were spent visiting some of the leading German universities, as well as many manufacturing, refining, and industrial establishments in Germany and France, thus giving him an opportunity of seeing and becoming familiar with a great variety of chemical operations on a large scale. During this tour he met many of the foremost chemists of the Continent. He saw Bunsen at Heidelberg, Erdmann at

[1] *Liebig-Wöhler Briefwechsel*, Bd. ii. S. 40.

Leipzig, and Fehling at Stuttgart. At Munich he met Pettenkofer and Buchner, but above all Liebig, the latter, unless we except Wöhler, the chief chemical figure in Europe. At Berlin he met Eilhard Mitscherlich, known by his discoveries in isomorphism, and the highly accomplished analytical chemist, Heinrich Rose, both, like his great teacher, pupils of Berzelius, one of the founders of modern chemistry. To this brilliant group of scientists should be added Christian Friedrich Schönbein, the chemical physicist and discoverer of gun-cotton and ozone, Gustav Magnus, August Wilhelm Hofmann, Rammelsberg, and the French chemist, Henri Sainte-Claire Deville. These he met, and many other scientific workers, and by all was cordially received, his investigations and discoveries in organic chemistry having already made his name familiar to them.

CHAPTER II

FIRST YEARS IN AMERICA

1857–1868

On the 12th of May 1857, Goessmann embarked at Bremen, in the steamship *Ariel*, for America. On his arrival at New York he proceeded at once to Philadelphia, and entered upon his duties as Chemist and General Superintendent of the Eastwick Brothers' Steam Sugar Refinery. He had brought from Germany considerable apparatus for the Eastwicks, and at once set about increasing the efficiency of their plant by introducing more scientific and economic methods for refining sugar, not the least important being the application of caustic magnesia with acid phosphate of lime.

He greatly improved the method of refining sugar by the defecation of solutions of crude cane sugar. He found by experiment that by employing in combination caustic magnesia (or magnesium hydroxide) with calcium hydroxide, better results were obtained than by the use of either reagent alone; and, further, that a thick cream of magnesium hydroxide and water, added to the warmed sugar liquor, gave better results than he or any one else had hitherto obtained.

During the following months he made a thorough study and investigation of the Chinese sugar-cane (*Sorghum saccharatum*), the results of which were published both in this country and Europe. From both a

chemical and an economic standpoint this elaborate research is one of the most valuable made in America respecting our knowledge of the plant and its products, its potentialities as a source of sugar, its method of culture, and the preparation of sugar and syrup from its juice. It was his opinion at the time that, provided the percentage of sugar in the sorghum could be increased in the same ratio as in the beet root, its successful cultivation would become an accomplished fact, and our farmers would be able to compete profitably with the planters of the West Indies.

In February 1862, he read a paper of great importance and interest before the New York State Agricultural Society, on the nature of *Sorghum saccharatum*, discussing at length the history of the plant, its chemical characters, the determination of the quality and quantity of sugar, and its value for agricultural and industrial purposes. Some four years earlier he had sent this exhaustive monograph to Wöhler, who gave it to Henneberg, and it was published in the *Journal für Landwirthschaft*. Returning to this subject ten years later, Goessmann says: 'I stated the results of a chemical investigation carried out by me in 1857, concerning the fitness of the sorghum cane for the manufacture of sugar and of superior syrups. These statements have been confirmed, as far as its yield of good quality of syrup is concerned; but the manufacture of sugar has not been tried to any extent, although there is no substantial reason why within some of the Southern States, with their favourable climate, a part of its sugar might not be advantageously secured in crystals.

A proper defecation of the sorghum juice before its concentration would doubtless accomplish that result. In making these statements here, I do not intend to assert that most of our Northern, and particularly our Northwestern States can profitably engage in the production of sorghum sugar. Localities liable to early frosts and short seasons had better confine themselves, if at all engaged in sorghum cultivation, to the manufacture of syrups, for unripe cane is entirely unfit for the manufacture of crystallized sugar. The Middle and some of the Southern States have apparently not sufficiently appreciated the value of this crop.'

At the beginning of December 1860, Goessmann abruptly terminated his engagement with the Eastwicks, and went at once to Cuba, for the purpose of studying the agricultural industries, especially the cultivation of sugar and tobacco, of the West Indies. There he remained nearly four months, visiting many plantations, witnessing the working of the sugar-cane, experimenting with the juice, and thoroughly investigating the processes of manufacturing and refining sugar in the island.

On his return from the West Indies in March of 1861 he was invited by Dr. George H. Cook,[1] professor of geology at Rutgers College and state geologist of New Jersey, 'to participate in a scientific investigation for the improvement of the manufacture of dairy salt at Syracuse, New York.' Goessmann seems to have made a favourable impression at Syracuse, as he was offered,

[1] In 1852 Dr. Cook was sent abroad by the State of New York to study the salt deposits of Europe.

and accepted, the position of Chemist and Superintendent of the Salt Company of Onondaga.

This company had been established near Syracuse in March 1860 — about a year, therefore, before Dr. Goessmann's appointment. It was formed, not only for the purpose of uniting the interests of the different manufacturers of Onondaga salt, but in order to secure a more thorough and systematic management, to reduce the cost of manufacture, and to improve and give uniformity to the character and quality of Onondaga salt. Such a co-operation of interests under a single control would doubtless now be stigmatized as a monopoly and 'trust.'

'Regarding as of the utmost importance that a perfectly pure salt should be furnished for the use of all engaged in making an article of such universal use as butter, and fully appreciating the necessity of such perfect uniformity in its quality as to command the confidence of dairymen, the Salt Company of Onondaga has placed the manufacture of its Factory-filled Dairy Salt under the superintendence of an accomplished chemist, who has for several years past made agricultural and manufacturing chemistry his specialty, — Dr. C. A. Goessmann, a graduate of, and for some years a teacher in the German University of Göttingen, — and who has for more than a year past devoted his entire attention, in the employment of this company, to the improvement of the processes of manufacturing salt.'[1] The claim made by the company, of making '*the best Dairy Salt known to the world*,' under the cir-

[1] *Report of the Salt Company of Onondaga for 1862.*

cumstances was probably just; at least, according to Professor Cook, no mean authority, it was fully equal to the best imported salt. This statement was corroborated by Professor Porter, chemist to the New York State Agricultural Society, who said it was equal in purity to any of the foreign salts. 'Under the superintendence of Dr. Goessmann,' said a leading chemist in 1867, 'the Salt Company of Onondaga has succeeded in making the *best Dairy Salt in the world*.' In Goessmann's time the salt works at Syracuse produced annually eight million bushels of salt.

In the autumn of 1862 he was sent to Michigan to examine the brines and saline deposits at Saginaw — and here it may be mentioned that eight years later, in 1870, Dr. Samuel S. Garrigues of Ann Arbor, state inspector of salt and a former Göttingen student, visited Dr. Goessmann at Amherst, and together they framed the salt laws of Michigan.

In March 1866, he was appointed consulting correspondent of the American Bureau of Mines, and in October of that year was commissioned by the Board of Experts to undertake the technical, chemical, and industrial investigation of the recently discovered rock-salt deposit of Petite Anse Island, New Iberia, on Vermilion Bay, Louisiana. In November he visited the island, where he remained several weeks, studying the natural features, conditions, and commercial relations of its rock-salt deposit. The next year he made two visits to Canada, the first in the latter part of June and the second the last of December, for the purpose of ascertaining the extent of the saline

resources and the quality of the brines, especially at Goderich.

In 1862 he published his first paper on salines. This, the first of a series of reports to the State Superintendent of the Onondaga Salt Springs on the chemical composition of the brines, was followed by reports on the brines of Michigan, Ohio, Pennsylvania, West Virginia, Nebraska, Kansas, Kentucky, and Tennessee, on the rock-salt deposit of Petite Anse Island, on the salt resources of Goderich, Canada West, and by other contributions to the chemistry of mineral springs and natural brines. The report on the rock-salt deposit of Petite Anse Island — republished at Washington in the *Smithsonian Contributions to Knowledge* — was pronounced by Professor Hilgard, then state geologist of Mississippi, able and exhaustive, and confirmed that author's previous conjectures 'that the overlying strata were the equivalents of the formation described by him as the "Orange Sand" of Mississippi.'

The improvements introduced by Goessmann while superintendent at Onondaga, in the manufacture of pure dairy and table salt, were many and important. He devised an ingenious method for freeing pure sodium chloride, in the manufacture of salt, from the chlorides of calcium and magnesium. Previously it had been impossible effectually to remove those noxious and deleterious ingredients, and the product was bitter and unfit for either table or dairy use. He ladled the crude salt-crystals from the brines on to inclined dripboards, and then washed them with a saturated water solution of pure salt (sodium chloride). Such a solu-

tion does not dissolve sodium chloride, but being free from the other chlorides (unsaturated for them) it dissolved and removes them, leaving behind pure sodium chloride. He also invented a process for screening the salt, whereby it is separated into large and small crystals. The system of evaporating in pans, as recommended by him, was also adopted in the salt-works at Goderich, Canada.

Dr. T. Sterry Hunt, in his reports as director of the Geological Survey of the Dominion of Canada, expressed his 'deep sense of the value of Dr. Goessmann's important contributions to the chemistry of salt-making in New York.'

Professor John S. Newberry, in a paper on the rock-salt deposits of the Salina Group in Western New York, read before the New York Academy of Sciences, says: 'The unequal distribution of the "bitterns" in the brines and salt of different localities is an interesting feature in these salt deposits. In some places almost the only ingredient of the brine is chloride of sodium, and some of the rock-salt, as we have seen, is almost chemically pure; in other localities, perhaps not distant, the brine or the salt contains an abnormal quantity of the chlorides of calcium and magnesium and the sulphate of magnesia and soda. This problem has been carefully studied by Professor Chas. A. Goessmann, and he has suggested what is doubtless its true solution, viz., that in the progressive evaporation of a basin filled with water having the normal composition of sea-water, the substances held in solution will be precipitated in the inverse order of their solubility: — thus

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sulphate of lime (gypsum), the least soluble ingredient, will be the first thrown down, the chloride of sodium next, and lastly, if at all, the deliquescent salts which form the "bitterns." . . . This will account for the deposition of gypsum, of pure salt, and of unusually bitter salt, in different parts of the same basin.'

Facts illustrating this distribution of the solid content of salt water were reported by Goessmann from the salt-basin of the Upper Ohio, and similar facts have been brought to light in boring the wells about Goderich.

A few months after Dr. Goessmann had entered on his duties at Syracuse he was strongly urged by his friends — especially by Professor Chandler, then at Union College — to accept the professorship of chemistry in the Rensselaer Polytechnic Institute at Troy, which had recently become vacant through the death of Professor Elderhorst. In a letter from Professor Chandler to Vice-President Brinsmade, dated November 9, 1861, touching Goessmann, he says: 'When I worked as a pupil, under his direction in Wöhler's laboratory, he was universally beloved by the students, and was a model of all that is desirable in a teacher.' In his reply to a letter from Dr. Brinsmade, Goessmann strongly urged the desirability of a thorough course of instruction in chemistry and also submitted plans for a chemical laboratory. For two years, from 1862 to 1864, he filled the chair of chemistry and physics at the Institute and taught also mineralogy. He was succeeded by Dr. Henry B. Nason, a former pupil at Göttingen.

Goessmann gave up his position at the Institute with evident regret, but it was becoming more and more difficult to discharge properly the duties of both positions, and he could hardly afford to relinquish Syracuse for Troy. In a letter to Professor Drowne, he writes: —

'The necessity to look into my present condition more than before, for an advantageous and sure income, has mainly prompted me to decide finally, in view of many circumstances, for Syracuse. Just at the day when I received by a communication from W. Gurley, Esq., the information of my appointment as Professor, etc., I got a very advantageous offer from Boston. My present employers, in view of these offers, advanced my salary so as to make my present engagement more acceptable. I have here a well-supplied laboratory at my entire disposal, being permitted to attend to any kind of investigation I wish to, particularly during the winter season.'

Dr. Goessmann now found himself in a position to marry. On 22 October 1862, he married Mary Anna Clara, daughter of Edward Kinny of Syracuse. Mr. Kinny was a founder of the Church of St. John the Evangelist, and a charter member of the Society of St. Vincent de Paul. Mrs. Goessmann was educated in the private schools of Syracuse and at the Academy of Mount Saint Vincent-on-Hudson, where her kinswoman, Mother Angela Hughes, sister of the Archbishop, was then in charge.[1]

[1] Mrs. Goessmann died at Amherst, 13 October 1911. Their surviving children are Miss Helena T. and Miss Mary F. Goessmann of Amherst, Louis E. and Charles I. Goessmann of New York, and Mrs. Agnes R. Spratt of Brooklyn. A son, Henry Edward Victor, died 27 April 1882, during his junior year at the Agricultural College.

In 1863 Goessmann received a letter from Wöhler, saying that he had proposed him for the professorship of technical chemistry in the Herzogliche Technische Hochschule (formerly the Collegium Carolinum) at Braunschweig, and he knew that they were seriously considering him for that position, though a decision might not be reached for a year. This was yet another evidence of Wöhler's high regard, and was very gratifying to Goessmann.

Goessmann writes: —

'We are already sufficiently aware that political affairs in this country have so shaped themselves that the future is not promising. Consequently, my desire to return to the Fatherland under favourable conditions will not surprise you. How much, therefore, I have enjoyed your communication concerning such a prospect needs no further comment. . . . As for the present, I am still engaged here for this year, and at its close I may possibly receive a new offer. I leave here on your advice. Things will go on as they are, as I am looking forward to a definite answer from you in the autumn.'

Other letters passed between Wöhler and Goessmann on the subject of his return to Germany, before his final decision to remain in America.

CHAPTER III

THE CALL TO AMHERST

1868–1882

In May 1868 Dr. Goessmann was invited by the Trustees of the Massachusetts Agricultural College to the professorship of chemistry recently established by them. In December he removed to Amherst and entered on his duties. Henceforth the teaching of chemistry, research, and the diffusion of science in its relation to agriculture, became the absorbing occupations of his life.

Some years before the election of William S. Clark to the presidency of the Massachusetts Agricultural College several letters had passed between Goessmann and his old friend respecting a teaching position at Amherst. In a letter dated June 10, 1865, Colonel Clark writes: 'How would you like to teach practical chemistry or to be connected as teacher with a New England college?' Writing nearly two years later, on March 16, 1867, he says: 'This is to urgently beg you to visit me here in the month of May next. . . . We are about starting our new Agricultural College here and possibly may have work for you.' And again, in November following,[1] he writes: 'President Stearns [of

[1] A few months earlier Colonel Clark had resigned the chair of chemistry at Amherst College to accept the presidency of the Massachusetts Agricultural College, and his successor had not yet been appointed.

Amherst College] would like to have you come on here next week that he may see you with reference to lectures, etc. next term.'

Dr. Goessmann's letter accepting the Amherst Professorship runs as follows: —

SYRACUSE, *May* 16th, 1868.

COLONEL W. S. CLARK, Ph.D.
President of the Massachusetts Agricultural College,
Amherst, Mass.

DEAR SIR, —

Your favour of 13th inst., in which you announce to me my election as Professor of Chemistry in the Massachusetts Agricultural College at Amherst, came in due time to hand. I take the liberty of informing you, that I hereby accept that position on the conditions specified in your letter. I add at the same time, that I shall attend most cheerfully to my duties and thereby in my opinion aid you best in accomplishing the object for which your institute has been established. As soon as the present pressure in business shall permit me to settle upon an exact time for a visit at Amherst, — to consult on fixtures and apparatus, etc., for my particular branch of instruction, I propose to write again. Please accept my most sincere thanks for the kind interest taken in my behalf. I remain,

Very respectfully yours,
CHARLES ANTON GOESSMANN.

He was forty-one. President Clark thus describes him: 'The other professor [Goessmann] is not here.

He is coming on Friday. I am very sorry he could not be here to-day, for I would like to have you see him. He is a hearty, full-blooded, wide-awake, nervous German. I will not compare him with Agassiz, but I will say he is a man of a temperament something like his. We were fellow-students in a German university twenty years ago, and he was one of the best students of his time. When we graduated together, the professor came to me and said: "What do you think of that young man as an assistant for me?" "I think he is the very best man you can find." Said he, "I think just so," and immediately appointed him his assistant. That professor is the best chemist in the world. . . . I know there is not a better practical chemist in the United States than Dr. Goessmann. I anticipate that he will be a light in this country, right here among this people, and that scientific investigations and experiments will be carried on under his supervision here, by the students of this College, which will redound to the credit of the State, and to the credit of this Board, as connected with the College.' [1]

Elsewhere, he says: 'His large experience as a teacher, and his great familiarity with the applications of chemistry to the arts, qualify him, in a peculiar manner, for the important position of chemist in the Agricultural College. It is confidently expected that, under his supervision, analyses of commercial fertilizers will be made, and suitable experiments instituted,

[1] Address by President Clark on the 'Work and the Wants of the College,' before the State Board of Agriculture, meeting at Amherst, December 8, 1868.

CHARLES A. GOESSMANN
About 1875

to determine for what purposes and at what prices the farmers of the State should employ them.' [1]

'I know of his work as a scientific chemist,' said Professor Agassiz, 'and I do not believe that you could have had a better appointment. I believe that the gentleman is not only fully competent to fulfil his duties with honour to the institution and credit to himself, but I believe he is one of those men who will advance his science also, if he is not overburdened with local duties and with teaching. He is a foreigner. . . . It is not a very dangerous thing to take professors from foreign parts. I am such an one, and I have in a measure succeeded in making myself a native American.'

The duties of the new professorship included teaching 'four hours per day five days in the week during 39 weeks of the year. Also, to render assistance by chemical analysis or consultation, as required, to the amount of about one hour per day, if needed.' 'I shall expect of course,' says President Clark, 'to do what I can to render your duties agreeable and shall rely much upon you for advice and assistance in the most important enterprise with which I am entrusted. I intend to have the chemical department of the College equal to any in the country.'

The College had but just started. It was, moreover, an experiment and was feeling its way. A department of chemistry could hardly be said to exist. There was, to be sure, a modest building called the Chemical Laboratory, but it possessed neither apparatus nor

[1] *Sixth Annual Report of the Massachusetts Agricultural College*, January 1869.

fittings nor furniture, and was used as a gymnasium. Dr. Goessmann entered on his duties with zeal, devoting himself to the improvement of the equipment for both demonstration and research, and to the organization of courses of lectures and laboratory instruction. He not only organized and established this department on a firm and enduring basis, laying the foundation broad and deep, but from the first he stamped his influence and personality on the structural growth of the College, and was a guiding and controlling spirit in shaping its policy. The reputation which the institution attained, almost from the beginning, was in large measure due to him. His lectures were not only instructive, but inspiring, and not a few of his students remember him with affection and respect as the most stimulating influence in their intellectual life. For fifteen years he gave unaided all the instruction in chemistry and chemical physics, both in the classroom and the laboratory. It was not until 1884, two years after the Experiment Station had been regularly organized, that an assistant professorship was established, thus relieving him of much tutorial work and some other college duties. He continued, however, to lecture to the Senior Class on the chemistry of fertilizers, the commercial industries, and on organic chemistry.

Agassiz had insisted that there should be more than one professor of chemistry, so that each should have some time to make investigations; 'for believe me,' he says, 'the professor who is exhausted by teaching cannot even learn what others do to keep up with the

times, still less contribute to the advancement of knowledge in his science.' Fortunately Agassiz's fears proved to be groundless. Goessmann's sturdy industry and scientific activity were enormous, and the yearly output of the Chemical Department in contributions far exceeded that of all the others. Chemical work was always in progress in some form. It should be remembered, too, that all the time he carried on a large and exacting correspondence with promptness, read papers, delivered public lectures, and attended to the analytical work of his private laboratory.

His first year at Amherst was marked by two highly interesting and instructive papers. The first of these, 'On the Chemistry of Common Salt with Reference to our Home Resources,' was read at the Northampton session of the National Academy of Sciences. The second, 'On Salt and its Uses in Agriculture,' delivered before the Massachusetts State Board of Agriculture, was his earliest paper on fertilization and may be considered, with one exception, his first direct contribution to agricultural chemistry. He also found time during that busy year to revise Scheerer's *Blowpipe Manual*, for use at the College.

In his letters to President Clark, Goessmann had insisted on the importance of experimental research, and in December of 1869 he proposed a series of experiments 'to determine the comparative merits of the various sugar-producing plants — maple, sorghum, cane, and sugar-beet — raised upon our own soil.' These were the earliest field experiments conducted at the College. Early in 1870 he procured from Germany

seeds of the thirteen best varieties of sugar-beets cultivated in Saxony and Prussia, and showed by trial those best adapted to our soil and climate for the production of sugar and syrup from the root. These experiments were carried out between 1870 and 1874, and appear to have been the first scientific experiments in sugar-beet culture in this country.

The reports[1] constitute an important contribution to agricultural literature. At the time they attracted wide attention, both in this country and Canada, leading to similar experiments under his direction in New York and the Dominion, the latter at the request of the Secretary of the Department of Agriculture and Public Works, with reference to the cultivation of the sugar-beet throughout the Province of Quebec. He demonstrated conclusively that the beet-sugar industry, which has added so largely to the wealth of France and Germany, can be profitably pursued in the northern states of North America and Canada; and that it is possible to grow beets of high sugar content in Massachusetts upon well-drained mellow loams (a rich, first-class barley soil) when proper attention is given to fertilization and cultivation.

In 1870 the *American Chemist* was launched by Charles F. and William H. Chandler, with the assistance of several leading chemists, among whom were Alsberg, Barker, Bolton, Egleston, Joy, and Goessmann. During the few years of its existence Goessmann was a regular contributor to its pages.

[1] 'The report,' says a writer in the *Scientific American*, 'is one of the most valuable contributions to agricultural science that has been made in our country, and reflects great credit upon its author.'

In January 1873 he printed an exhaustive paper on 'Commercial Fertilizers.' Able and full of valuable facts and suggestions, it was pronounced the most important essay on that subject which had yet appeared in this country. One of the immediate results of the discussion induced by this report was the enactment of a law — the first of its kind in the United States — regulating their manufacture and sale; or, in the trenchant language of Goessmann, its author, the object of the law is to compel the dealers in these articles '*to state what they sell and to sell what they state.*' This law for fertilizer control, compelling commercial manures to be sold according to a guaranteed composition to be ascertained by chemical analysis, thereby protecting the honest dealer and manufacturer as well as the farmer, revolutionized the fertilizer trade of the country, and served as the model and inspiration for all subsequent legislation of the kind in other states. For thirty-five years Dr. Goessmann was charged with the administration and execution of this law in Massachusetts.

Early in the year he had been appointed Chemist of the Massachusetts State Board of Agriculture. With the passage of the fertilizer law, he became *ex officio* a member of the Board and State Inspector of Fertilizers. One of the duties of the State Inspector was to make an annual report to the Board of Agriculture. Professor Julius A. Stöckhardt of Saxony, the distinguished agricultural chemist, closes his review of Goessmann's first report on commercial fertilizers as follows: 'There can be no doubt that in America

satisfactory and reliable fertilizers can be obtained, as they were in Germany, by strictly adhering to the *chemical control* adopted, and by providing for chemistry what it needs for efficient work — both confidence and ample means.' Professor Atwater called the report a very valuable pamphlet upon the sources of supply and quality of the more important fertilizing materials used in Massachusetts.

'Stable-manure,' says Goessmann in this report, 'is still the main fertilizer in ordinary farm operations, yet its peculiar value to-day rests more on its beneficial influence on the physical condition of the soil than on its effect on the chemical composition of the latter.' By a tabular statement of the ingredients he shows that, although the most complex of our common fertilizers, it is a complete manure only in exceptional cases, and that the permanent improvement of the soil depends almost entirely upon the introduction of other substances, such as the guanos and phosphates.

'All friends of the College,' said President Clark of the second report, 'ought to be grateful for the production of a paper which combines most happily scientific knowledge with practical wisdom.' Hon. Marshall P. Wilder declared, that these two reports were 'worth more to the Commonwealth than all that had been expended for the maintenance of the Board since its first organization.' Among the well-known members of the Board of Agriculture at that time were Louis Agassiz, William S. Clark, Charles L. Flint, Charles G. Davis, William Knowlton, George B. Loring, Charles S. Sargent, Levi Stockbridge, Joseph N. Sturtevant,

and Marshall P. Wilder. A year later Paul A. Chadbourne was appointed to fill the vacancy in the Board occasioned by the death of Agassiz. Standing pre-eminent among the technical and agricultural chemists of the country, Goessmann was the pride of the Board, as Hitchcock and Agassiz had been before him, and from 1874 till his death he was one of its most distinguished members and the principal contributor to its reports.

In 1874 Goessmann began a systematic investigation, extending over six years, of the chemical and physical condition of the salt marshes of the State, especially above the mouth of Green Harbor River in the town of Marshfield, and showed the best method of reclaiming and subduing them and making them available for tillage. His reports upon the composition of the soil and beach sand at Marshfield, and the chemical changes occurring as the result of diking, resulted within a short time in the reclamation of large tracts of a similar character with those under experiment at Green Harbor. The same year he made a thorough examination and trial for agricultural purposes of the South Carolina phosphates, both in the raw state and after treatment with acids. In 1876 and the two following years experiments with various fertilizers upon sugar-cane were carried out under his direction at Calumet Plantation, Bayou Têche, Louisiana.

While Robert Koch was pursuing his researches upon the bacillus of tuberculosis, Goessmann, assisted by Penhallow, was studying the relation of special fertilizers to certain diseases of plants, hitherto supposed

to be parasitic in origin. He maintained that the disease of peach trees known as 'the yellows' was due to impaired nutrition, and that after treatment with a phosphatic fertilizer in connexion with potassium chloride they become vigorous and healthy.

During the Centennial Exposition at Philadelphia one of the French Commissioners visited the College vineyards at Amherst, then under treatment with special fertilizers for the *Phylloxera*, and observed that nowhere had he seen more vigorous vines or better developed fruit, expressing surprise that such should be the case. 'We feed the vines and the *Phylloxera* too,' said Dr. Goessmann in reply; 'the excessive supply of food to the vines giving them a stimulation which enables them to resist successfully the effects of the parasite.'

Between 1874 and 1876, with his able assistant, David P. Penhallow, he investigated the physiological effect of special chemical fertilizers upon the carbohydrate content of various fruit-bearing plants and the quality of the fruit. He studied especially the behaviour of certain wild and cultivated grape-vines under the influence of different fertilizing agents, whereby the amount of acid, sugar, and ether in the fruit may be increased or modified and the formation of the aromatic principles peculiar to the species promoted even to the flavour of the fruit and the bouquet of wines. He found also 'that the colouring matter which is characteristic of the ripe grape is already, in some concealed form, present at a very early stage of its growth.' These experiments on the relation of the

mineral constituents of plants to the growth of the organs of vegetation — that is, the changes in their chemical composition during growth — and the quality and ripening of fruits, he considered of great importance, as they might enable us to modify at will the relative proportions of acid, sugar, and ether in our fruits, and, thereby, produce practically new varieties of superior quality and market value.

Goessmann co-operated also with President Clark and Professor Peabody in the study of the circulation and flow of sap in plants; with Professor Stockbridge in the study of special fertilization and the behaviour of soil waters; and with Professor Maynard in a series of field experiments with grape-vines and various fruit trees, extending over several years, for the purpose of testing the action of different kinds of plant-food on their productiveness in the quantity and quality of the fruit. In 1878 he published an interesting paper on the effect of girdling upon the growth, composition, and quality of grapes, proving conclusively that those growing on properly girdled branches ripen much earlier than those on ungirdled branches. During those busy years he found time to write several articles, chiefly on beet and cane-sugar, fertilizers, and salt, for *Johnson's New Universal Cyclopædia*, for many years the standard work of its kind in America.

In January 1878, with the approval of the Trustees, the Massachusetts Experimental Station was established at Amherst, Professor Stockbridge having generously offered the sum of one thousand dollars to defray the necessary expenses of agricultural experiments

for one year. This, although merely a private enterprise, was the forerunner of the Massachusetts Agricultural Experiment Station established by act of the legislature four years later, and of its successor, the Hatch Station. It should be remembered, however, that an experiment station, having as its aim systematic research for the improvement of agriculture and the dissemination of practical knowledge relating thereto, had existed at the College — in fact, if not in name — since 1870. For eight years the Chemical Department had been conducting the work of an experiment station, and Dr. Goessmann's extensive experiments in sugar-beet culture, and the published results of that memorable investigation were its first fruits.

As pointed out by Penhallow, the scientific observations of Clark, Goessmann, and Stockbridge from 1870 to 1876 constituted the real beginning of the Station and gave a powerful impetus to a movement which has since resulted in the establishment of similar stations throughout the United States and Canada. Looking back on those early years one marvels at their productiveness, at the scope and quality of the work, and all the more as little or no provision then existed for meeting the necessary expenses of such operations.

The value of agricultural experiment stations had long been recognized in Europe. As early as 1836 Jean-Baptiste Boussingault was conducting, at Bechelbronn in Alsace, his noted experiments with stock-feeding to test the efficiency of *fodder rations*. Seven years later, in 1843, John Bennet Lawes established at Rotham-

sted, near London, his world-famous model station for the investigation of problems relating to plant-nutrition. It should be remembered, however, that Lawes had been experimenting since 1834, and hence the Rothamsted Station has been called the oldest agricultural station in the world. In 1849 Emil Wolff founded at Möckern in Saxony the first agricultural station in Germany, and by 1876 there were no fewer than sixty-two such stations in successful operation in the German Empire. The first agricultural experiment station in America was established at Middletown in 1875, in the chemical laboratory of Wesleyan University. The Massachusetts station was among the earliest — if not the earliest — to be associated with a land-grant college, and the second — the Connecticut station at New Haven, established in 1877, being the first — to be incorporated in the United States. But it should not be forgotten that field and feeding experiments were carried on in the sixties at both the Michigan and the Pennsylvania State Colleges — at the former by Robert C. Kedzie and Manly Miles, at the latter by Evan Pugh, then fresh from Rothamsted and the first president and professor of chemistry of the Pennsylvania State College.

The Trustees, gladly accepting the gift of Professor Stockbridge, at once appointed a committee — consisting of President Clark, Professor Stockbridge, Professor Goessmann, Secretary Flint, and Hon. Richard Goodman — with full power to act as the managers of the station.

Subjects for scientific observation and investigation

were now assigned to Professor Stockbridge and Professor Goessmann, respectively, the results of which appeared in the next annual report of the College. Those assigned to Professor Stockbridge included observations on rainfall, percolation and evaporation of water from the soil, temperature of soil and air, deposition of dew on the soil and plant. Dr. Goessmann undertook an examination of the Early Amber Cane, — a variety of sorghum produced in Minnesota, — its sugar constituents, and the practical method of working the crop. His experiments seemed to show conclusively that this variety of sorghum cannot be profitably cultivated in Massachusetts for the production of dry sugar, though the yield and quality of the syrup were satisfactory.

The problems relating to the nutrition of plants had long occupied Goessmann's thought. He now turned his attention more particularly to those of animal nutrition or the chemical relations which exist between animal life and animal food. His earliest investigation in this field was on the relative value of several varieties of corn for feeding purposes, and the results and conclusions reached were embodied in two papers read before the Board of Agriculture in 1879 and 1882. These experiments, and others of a similar character, extending over a series of years, were undertaken in order to determine the efficiency and feeding-value of the various kinds of fodder-crops and substances and thereby to establish a rational system of stock-feeding.

On the 12th of May 1882, by act of the Legislature, the Massachusetts Agricultural Experiment Station

was established at Amherst for the scientific investigation of problems relating to agriculture. The Board of Control of the new station organized for work in July, and in November Dr. Goessmann was appointed Director and Chemist. From 1888 to 1895 he was *ex officio* a member of the Board, and from 1892 to 1895 Treasurer of the Station. In 1895 the Massachusetts Station became merged in the so-called Hatch Experiment Station of the College, and he retired from the directorship with the title of Honorary Director, and was placed in charge of the chemical-fertilizer and fertilizer-control work, a position he filled until his retirement in 1907. Happily, the 'Hatch' has since been dropped and the earlier and more euphonious name restored.

In the early years Professor Manly Miles and Professor Samuel T. Maynard were associated with Dr. Goessmann in the work of the Station — the former as superintendent of field and stock experiments, the latter as superintendent of horticultural experiments, microscopist, and draughtsman. In 1888 Dr. James E. Humphrey was appointed vegetable physiologist and mycologist, and in 1892 Dr. Joseph B. Lindsey became associate chemist. These investigators contributed many papers in various lines of research to the bulletins and annual reports of the Director.

CHAPTER IV

INVESTIGATIONS AT THE COLLEGE

Wöhler and his co-workers had inspired young Goessmann with the spirit of investigation. He had not been at the College long before he began a study of Massachusetts agriculture, and the application of chemistry thereto. During his long period of service he investigated a large number of agricultural problems, the more important of which are referred to in the pages which follow.

I. PRODUCTION OF BEET SUGAR IN MASSACHUSETTS

First Paper. Report on the production of beet sugar as an agricultural enterprise in Massachusetts. (*Eighth Report of the Massachusetts Agricultural College*, 1871.)

In this paper he called attention to the large amount of sugar imported into the United States, reviewed briefly the sugar-cane industry of Louisiana, and then gave a most instructive account of the entire method of sugar-beet cultivation and manufacture in Europe and of the general condition of the European sugar industry. He declared that the success of the beet-sugar industry in the United States depended, first, 'on a careful selection of superior seeds of the best foreign varieties, and subsequently of the choicest seed beets; and, secondly, on the proper choice of lands which are not only adapted to the cultivation of root-crops in

general, but are in such a state of fertility as to enable the farmer to supply the kind and amount of plant-food required for the production of a special crop for a special purpose.'

In an appendix to the report are presented photographs and weights of different varieties of beets grown upon the College farm and the sugar content of the same.

Second Paper. Report on sugar beets raised upon the College farm. (*Ninth Report of the Massachusetts Agricultural College,* 1872.)

This paper gave the results of his own experiments in the field and laboratory along three distinct lines: (*a*) methods for producing good sugar beets in accordance with the rules stated in his previous report; (*b*) a study of the chemical properties of the sugar beets grown on the College farm, with reference to their fitness for beet-sugar manufacture; and (*c*) a study by actual tests of the amount of sugar available for commercial purposes.

The paper described in detail the selection of soil, method of planting, care of the crop during the growing period, and method of fertilization. He also discussed the effect of potash salts on the basis of German investigations. He further presented data relative to the weights of the different varieties of beets grown upon the College farm and their sugar content at different stages of growth; also the amount of nitrogenous substance and ash contained in the juices. In the process of extracting the sugar he followed, on a small scale,

the method in use at the time in foreign beet-sugar factories for the removal of the sugar, and found that substantially 1,900 pounds could be secured from an average acre of beets. He stated that, if the same equipment were available as employed in foreign sugar factories, he believed that beets raised in Massachusetts could be made to yield as high as 2,270 pounds of sugar per acre, the amount under favourable conditions then secured in Germany. His object in conducting these experiments was to demonstrate that by following the methods of cultivation then in vogue in Germany and France it was perfectly feasible to develop the sugar-beet industry in Massachusetts.

In the *Tenth Report* of the College John C. Dillon, the farm superintendent, gives an illustrated description of the machinery, imported from Germany under the advice of Goessmann for the cultivation of the sugar beet, which included a beet planter, several beet cultivators, and a beet digger.

Third Paper. Report on experiments with sugar beets. (*Eleventh Report of the Massachusetts Agricultural College*, 1874.) The paper was devoted to the results of four field experiments with beets conducted on the College grounds, and also in New York State and in Canada.

In Experiment I, roots of the Vilmorin and Electoral varieties were grown upon land which had produced a crop of beets the previous season, and which received as a special fertilizer kainit and bone superphosphate. The seed was collected and the next year planted on

suitable land properly fertilized. The juice from the beets contained some 14 per cent. cane sugar, and the beets were equal to the best thus far produced at the College.

In Experiment II, 100 pounds of beet seed were imported from Saxony. Four acres of beets were planted from this seed on the College farm. Ten pounds of the same seed were sent to the New York Agricultural Society and planted by six farmers in different parts of the state. Samples of the beets grown were sent to Goessmann, who found the juice to contain all the way from 7.37 to 15.10 per cent. of sugar. The wide variations he believed to be due to the method of fertilization. Highly nitrogenous manure, or the application of partly decomposed stable-manure in the spring, was considered particularly objectionable, causing an increase in the amount of impurity in the juice and preventing a favourable development of the sugar. He stated that a satisfactory juice should not contain over one part of impurity to five parts of sugar. He laid particular stress upon planting the beets in deep mellow loams that had not been too heavily manured. The application of well-rotted stable manure in the spring, or preferably the year previous to planting the beets, was advised, and supplementing the same with sulphate of potash and superphosphate.

Experiment III was conducted on the College farm. He found fresh horse-manure to be quite unfavourable to the development of cane sugar. Land that had received stable manure two years previously, and that receiving sulphate of potash, produced beets containing

the highest percentages of sugar (12.19 and 12.78 per cent).

Experiment IV gives the results of tests made by Goessmann of beets grown in Canada under the supervision of the Canadian Department of Agriculture. The sugar percentage varied from 8.83 to 11.38. He concluded that a stricter compliance with the well-endorsed rules of cultivation will, no doubt, produce a higher and thus a satisfactory quality of sugar beets in both localities.

Fourth Paper. On the cultivation of the sugar beet for the manufacture of sugar. (*Agriculture of Massachusetts*, 1879.)

Professor Goessmann presented a comprehensive paper, giving the results of his experiments with sugar at the College and also a review of the best methods of sugar-beet cultivation, manufacture, and utilization of by-products which were employed in Europe at that time. His several papers attracted the attention of thoughtful men all over the country as well as in Canada. He believed that the production of beet sugar would, at some time, be a Massachusetts industry. The only difficulty he foresaw was in securing co-operation between the farmer and the capitalist. At the conclusion of his final paper on the subject, he says, that the 'future prospect of the beet-sugar manufacture rests largely with the decision of our farmers, whether they are willing to unite with our capitalists in sharing the responsibility of the new industry.'

Goessmann was a pioneer in advocating the beet-

sugar industry in the United States, and although he never saw his prophecy realized in Massachusetts because of the more profitable use of the land for other crops, his teachings concerning the cultivation and fertilization of the beet hold true at the present time, and he lived to see a large beet-sugar industry developed in California, Colorado, Idaho, Utah, and Michigan. The present area in the United States devoted to sugar beets is some 624,000 acres which produced in 1915, in round numbers, 862,800 tons of sugar.[1]

II. RECLAMATION OF SALT MARSHES

First Paper. On the best mode of subduing and utilizing for tillage the salt marshes in this state, after they are drained. (*Agriculture of Massachusetts*, 1874.) In this paper he 'gives the origin, the general character, and the agricultural history of a few successfully reclaimed sea-marshes of Europe, for the purpose of rendering more prominent some striking features of similarity which exist between them and the recently diked marshes above the mouth of Green Harbor River in the township of Marshfield, Plymouth County, Massachusetts.' He described in some detail 'gradual changes which the original vegetation was undergoing since the water of the ocean has been excluded, in consequence of the construction of an efficient dike, pointing out on the same occasion some of the causes which seemed to control the still varying or broken-up aspect of the present natural growth in the different sections of the salt marshes.'

[1] *Yearbook of the Department of Agriculture*, 1915, p. 497.

From a study of water taken from the subsoil in different parts of the marsh lands, of samples of soil, and of the crops raised the first season, he advised as absolutely indispensable the adoption of an efficient system of drainage, after which attention should be given to the improvement of the chemical and physical condition of the soil by thorough cultivation.

Second Paper. Report on the salt marshes above the mouth of Green Harbor River in the township of Marshfield, Plymouth County, Massachusetts. (*Agriculture of Massachusetts*, 1875.)

This paper was a continuation of Dr. Goessmann's report on the reclaimed salt marshes in Marshfield. As a result of drainage he found an improvement over the previous year in the composition and level of the subsoil waters, resulting in a change in the colour of the surface soil and the rapid decomposition of organic matter underlying the sod. Wherever drainage was poor on account of a hard clay subsoil, vegetation was killed or seriously injured by an excessive amount of salines in the soil. Only a small part of the best-drained land was suitable for general cultivation as yet, the greater part of it being seeded to grass without ploughing. Both grass and vegetables gave promise of good crops until largely destroyed by grasshoppers in late June.

He recommended that one general plan for the drainage of the entire area of the marshes be devised and put in operation, and that the land be thoroughly ploughed wherever the sod became too spongy to support a good grass crop.

Third Paper. On the improvement of salt marshes. (*Agriculture of Massachusetts*, 1876.)

This was a further report on the Marshfield marsh lands. The condition of the land and crops was encouraging, although some failures were experienced, and similar failures were to be expected for some years until the land had been under cultivation long enough to get the soil into better physical condition. The examination of soil and of drainage waters showed that inefficient drainage even in the vicinity of the river was still the main cause of crop-failures. He stated that all attempts to establish a rational system of tillage would fail so long, and in the same degree, as efficient drainage was neglected. He then outlined a plan for a drainage system of which the river with its tributaries should be the centre from which the main ditches should start, and to which all ditches should have an outlet. The old ditches in many instances might become links in this new system. He again recommended ploughing as soon as the soil failed to produce a good grass crop due to the breaking down of the old sod. He made no definite recommendations as to a system of crop rotation, but advised that for some years crops should be selected with a view to improving the mechanical condition of the soil, and that a rotation of crops should be chosen, with the aim not only of economizing the latent plant-food, but also of preserving a liberal amount of organic matter in the soil.

Fourth Paper. The improvement of salt marshes in the town of Marshfield, made together with George M.

Baker. (*Agriculture of Massachusetts*, 1877.) This is a report of progress in which is shown that of the total area of 1,250 acres of marsh land, some 250 acres were under cultivation, including 50 acres which had been ploughed. A partial summary of the various crops raised is given. He placed great emphasis upon a more thorough system of drainage. After this had been accomplished he felt sure that the marsh area would become very valuable for agricultural purposes. Attention was called to the claim for damages likely to be made for alleged injuries to the harbour as a result of drainage of the marshes. This matter had resulted in causing some owners to refrain from further drainage plans until it was settled.

Fifth Paper. The same title as fourth paper. (*Agriculture of Massachusetts*, 1878.) The dike which was constructed to keep out the sea-water proved its worth on the entire area of marsh and 'shows, year after year, more decided signs of a progressing decay within its accumulated vegetable matter, in particular in that portion of it which directly underlies the surface growth.' He regrets that a more general drainage plan has not been adopted, feeling sure that if the matter was undertaken in a thorough manner together with a liberal use of the plough, the marsh area would become very productive.

Sixth and Seventh Papers. The same title as fourth paper. (*Agriculture of Massachusetts*, 1879 and 1880.) Brief reports of the same tenor as fourth and fifth papers.

The year 1880 proved unfortunate for crop-production on the reclaimed areas because of very dry weather during the early part of the season. He concludes this series of papers as follows: 'We believe the community never had more confidence in the richness and fertility of the soil than they have to-day. Evidently, nothing but a favourable decision of the courts is needed to secure outside capital for more general and rapid development of the agricultural resources of the reclaimed sea-marshes at Marshfield.'

III. RELATIVE VALUE OF SEVERAL VARIETIES OF CORN FOR FEEDING PURPOSES

(*Agriculture of Massachusetts*, 1879.) The paper begins with an historical account of the work done on animal nutrition, dividing it roughly into four periods.

The early attempts to inquire into chemical relations between animal life and animal food, beginning with Lavoisier in 1780 and continuing for the next fifty years, were of but little practical value to agriculturists, because of the uncertainty of the chemical methods used, and also because stock-feeding had not at that time received much attention.

The second period began in 1836 with the work of Boussingault and Liebig. The most important service rendered by Boussingault to the science of rational stock-feeding consists in the introduction of the *chemical analysis* as an *essential requirement* for the determination of the feeding value of an article of fodder. Boussingault was of the opinion that the nitrogen alone of the fodder constituents was of direct feeding value,

while the non-nitrogenous materials served merely as the support of animal respiration. Liebig, on the other hand, recognized that no single constituent of a plant can support animal life — neither nitrogenous matter nor fat, neither sugar nor mineral substance: it requires a certain definite proportion of each for different classes of animals, and even for different conditions of one and the same animal.

To this period belongs the practice of classifying agricultural fodder-crops by making hay the standard for the determination of their relative feeding value. At first this was merely a comparison of the market values of different fodders; but later the basis of comparison was changed to make the chemical analysis of good meadow hay the basis of the classification of fodder crops. This method of comparison continued in force for many years, but became more and more unsatisfactory as a greater variety of fodder crops became common.

The efforts of these two leaders in rational agriculture (Boussingault and Liebig) to turn chemistry to practical account in agricultural operations, soon led to a more general introduction of agricultural experiment stations. Much analytical work and many feeding experiments conducted at these experiment stations, showed that no one plant can furnish a standard for a general fodder-valuation, and that no single definite numerical expression can state the relative or absolute feeding value of any fodder. Gradually it became clear that a knowledge of the chemical composition of the fodder articles alone was not sufficient to determine

their exact feeding value, but that the degree of their digestibility exerted a controlling influence on their qualification to support animal life.

Grouven conducted a series of experiments (1860–1864) which have revolutionized the science of stock-feeding. He concluded that a rational and economical system of feeding farm stock required the following information: 'First, how much nitrogenous matter, how much carbohydrate and fatty matter, and how much mineral substance in a digestible form does each kind of animal require, not only in its various stages of growth, but also for every purpose it is designed to answer? Second, how much of each of these four groups of substances is present in a digestible state in our various articles of fodder?' Aside from his own contributions to this subject, Grouven attempted to bring the valuable results of previous scientific research within reach of the practical farmer.

Dr. Goessmann then explained the terms used in reporting the results of his analysis of different kinds of corn. All plants, including most of our common articles of fodder, contain four groups of nutritive compounds: protein or nitrogenous substance, carbohydrate or non-nitrogenous substance, fats, and mineral constituents. These are present in absolutely and relatively varying quantities in each plant and part of plant, and serve in absolutely and relatively different proportions for the support of animal life. The nutritive ratio of a fodder substance is the numerical relation of its nitrogenous substance compared

with the sum of its non-nitrogenous digestible organic constituents, fat included.

Then follows a detailed report of the analyses of eleven varieties of corn, including analyses of different parts of the corn plant. From these analyses and from a knowledge of the conditions under which the different samples were grown, he concludes that the difference in feeding value of the different samples is due as much to the method of cultivation as to difference of variety. The analyses indicate that the feeding value of corn-cobs is equal to that of some grasses, and is greater where the final processes of growth are stopped by the weather. They are especially valuable ground with the corn kernel.

The paper ends with a brief description of the method of making and feeding ensilage, together with the analyses of several samples of corn at the time of putting into the silo and after fermentation.

IV. THE SYSTEM OF PRESERVING GREEN FOOD IN SILOS

(*Agriculture of Massachusetts*, 1880.) This paper calls attention first to the fact that opposite views of the value of the silo system are held, and explains this as due to a misapprehension regarding the composition and feeding value of the ensilage as compared with the original green crop, and to a different basis for the estimation of the economic points involved.

Goessmann then takes up the use of the silo system in Europe. A general description of the method of preserving green feeds in silos and the kinds of feeds for which this treatment is recommended follows. The

success of the operation depends upon the dryness of the pit in which the material is packed, the careful packing down of the mass in the silo, especially along the sides, and the keeping out of the air, particularly during the earlier period of fermentation. During the process of fermentation the green feed loses weight, due to the loss of more or less organic matter and water. Some of the starchy or saccharine substances are changed to lactic acid, and sometimes to alcohols and fatty acids. The nitrogen percentage is usually higher than that of the green feed.

After this general discussion of the method, he describes a number of European experiments with ensiling different crops, including clover, the leaves and tops of beet-roots, and sugar-beet pulp and straw combined with a green crop, giving in each case the chemical changes which took place in the product.

From these examples he concludes: 'That the silo system furnishes no exception to the rule that our practical modes of preserving fodder are accompanied with a loss in quantity and quality of valuable plant constituents, and that any attainable higher feeding value is almost invariably secured at the sacrifice of quantity. The question of waste is simply a matter of degree when comparing existing modes of keeping fodder with that of the silo system.'

There are some advantages which the silo system possesses over other systems. It is independent of the weather. This is of particular importance in the case of juicy plants. Exposure of green crops to rain, even for a few days during hay-making, alters the quality of

the hay more than is commonly supposed. Fodder plants like clover lose largely in value during haymaking, due to the loss of leaves. Both of these sources of loss are avoided in the use of the silo. The quality and quantity of ensilage made with ordinary care suffers mainly from but one thing, fermentation. Admitting that this waste may be greater than that of any mode of preserving fodder, there are some advantages which ensilage possesses for which it is difficult to find an exact numerical value as compared with dry fodder of the same plant: namely, it increases the rate of digestibility of otherwise indigestible parts of the green fodder, thereby compensating somewhat for the loss of valuable soluble organic matter; and the ensilage of those crops for which the system is recommended is almost invariably more acceptable to animals than the dry fodder. The silo system is not a substitute for existing modes of preserving fodder, but will prove a most valuable assistance to increase our chances of securing larger quantities of good fodder.

V. THE INSPECTION OF COMMERCIAL FERTILIZERS

Commercial fertilizers began to attract attention in the United States as early as 1853. In that year Samuel W. Johnson published the now historic article on Superphosphate of Lime.[1] As chemist to the Connecticut Agricultural Society from 1856 to 1861, and later as chemist to the Connecticut State Board of Agriculture, Johnson issued reports which included numerous

[1] *Country Gentleman*, March 1853.

analyses of commercial fertilizers then being sold in that state.

As early as 1852 one notes references to the use of Peruvian guano and superphosphate of lime in the report of the Massachusetts State Board of Agriculture. In 1865 Dr. James R. Nichols,[1] in an essay before the State Board, discussed in an admirable way the subject of plant-nutrition and made especial reference to phosphate from bones, potash from ashes, and the probability of plants taking their nitrogen from the air. In 1868 Col. Mason C. Weld[2] delivered an address before the same society on Commercial Fertilizers, reflecting the best knowledge of the day. He showed Peruvian guano to be retailing for $62.50 a ton, superphosphate of lime for $55, ground bone and ground fish for $45, nitrate of soda for $120, and sulphate of ammonia for $170. He also stated that many brands of highly recommended fertilizer mixtures were being offered for sale and were generally purchased by the poorest farmers, whereas in Europe such conditions were reversed. Dr. Nichols[3] delivered another address before the State Board in 1870, entitled 'Manures, General and Special.' He published a number of analyses made by himself of ashes, fish, and several fertilizer mixtures, and commented upon the high prices of many of these substances and the frauds frequently practised. In 1871 another address by Nichols[4] followed, entitled 'Food of Plants and Sources of Supply,' which was

[1] *Agriculture of Massachusetts*, Fourteenth Report, p. 228.
[2] *Ibid.*, Sixteenth Report, p. 93.
[3] *Ibid.*, Eighteenth Report, p. 179.
[4] *Ibid.*, Nineteenth Report, p. 80.

discussed by different members of the Board and indicated the interest then being taken in the subject of commercial fertilizers in this state. In 1872 Andrew H. Ward[1] read a paper before the State Board on 'Manures and Fertilizers,' which caused considerable discussion by Col. William S. Clark and others, and emphasized the uncertainty of our knowledge concerning the value of commercial fertilizers in Massachusetts markets, and the great need of a systematic inspection.

Professor Goessmann, in the *Tenth Report of the Massachusetts Agricultural College* (1872), presented a very comprehensive unofficial report on commercial fertilizers, in which he summarized the knowledge on plant-nutrition and the use of fertilizers then prevailing in Europe, called attention to the imperative need of a law governing the sale of fertilizers in Massachusetts, and outlined the salient requirements of such a law. He further presented a number of his own analyses of the fertilizers found in the local markets, and discussed their relative commercial values and selling prices. In part II of this report he gave an excellent exposition of the formation, composition, and value of the recently discovered potash salts of Germany.

The first fertilizer law[2] in the United States *requiring an official inspection of fertilizers* was passed by the

[1] *Agriculture of Massachusetts*, Twentieth Report, p. 165.

[2] On February 5, 1873, it was voted by the State Board of Agriculture 'that Col. W. S. Clark, Professor Goessmann, and Secretary C. L. Flint constitute a committee to appear before the legislature in behalf of a law controlling the sale of fertilizers.' The records of the State Board fail to give further information; one may conclude, however, that the law was the result of the combined efforts of the above committee.

Massachusetts Legislature on May 26, 1873,[1] to become operative October 1 (Acts of 1873, Chapter 312). It required all fertilizers sold in the state to have a guarantee of composition attached, and provided a penalty for failure to do this. The execution of the law was placed under the supervision of the State Board of Agriculture, and the chemist of the Board was made state inspector of fertilizers. The fee was fifteen dollars for each analysis made, and was to be paid by the manufacturer to the state inspector to cover the cost of the inspection. The inspector was required to report any violation of the act to the secretary of the Board, who was empowered to institute legal proceedings.

Professor Goessmann, by virtue of his office, became the inspector, and published his first report in the twenty-first annual report of *Agriculture of Massachusetts*. Owing to the lateness of the season when the law went into effect (October 1), the report was of necessity limited in its scope. He reported the analysis and discussed the value of Peruvian and fish guanos, slaughter-house residues, superphosphates, sulphate of ammonia, nitrate of soda, and German potash salts. He advised the manufacturers to pay more attention to their analytical statements, and particularly to improve their methods of manufacture. In one of his early reports is found the following statement: 'These identical articles cost the farmers . . . one-half more than they ought to.' The inspection was transferred

[1] A preceding law enacted March 10, 1869 (Acts of 1869, Chapter 63), required that all fertilizers be marked with the name of the manufacturer and a statement of the analysis, and prescribed a fine for those violating it. No official inspector was appointed nor were funds provided for its execution.

from the chemist of the Board in 1883 to the director and chemist of the newly organized State Experiment Station, of which he was the head. After the consolidation of the state and Hatch stations in 1896, the president of the College, as director of the combined stations, became officially the inspector, but the execution of the work was carried out by Professor Goessmann as chemist of the Station, and he continued it until his retirement in 1907.

In the early years he made his own collection of samples and performed much of the analytical work. As the demands upon his time increased, he employed as aids, both in collecting samples and as chemists, recent graduates of the College who had been trained under him, and it is recalled that in the summer of 1884 the writer made practically all of the nitrogen determinations at the College laboratory by the old soda-lime method, and at the end of each day carried the bulbs containing the resulting chloride of ammonia to the professor's private laboratory where the process was completed by the professor himself.

The reports of the inspection issued by Professor Goessmann from year to year grew in importance, and were regarded by farmers as a strong bulwark of protection against misrepresentation and fraud. In fact, the more progressive manufacturers soon recognized the justice of his statements, endorsed the law, and supported him in his work. One cannot estimate in money the value of the services thus rendered to the citizens of Massachusetts by Goessmann and his coworkers. It has been said by educated men who pos-

sessed an intelligent grasp of the situation, that this work alone was worth to the state the entire cost of the Agricultural College.

VI. THE VALUE OF EARLY AMBER SORGHUM AS A SUGAR PRODUCING PLANT

(*Sixteenth Report of the Massachusetts Agricultural College*, 1879.) This experiment was conducted to ascertain the value of the Minnesota Early Amber Sorghum upon the soil of Massachusetts. Seed was secured through the United States Department of Agriculture, and one acre was grown at the College and about twenty acres in the vicinity. The apparatus used for crushing and pressing the cane and evaporating the juice was the same as that used in Minnesota. Only such apparatus and methods were used as could be employed by any intelligent farmer with a moderate outlay of money.

Dr. Goessmann's part in this experiment was to study the changes which the cane undergoes during the later period of its growth, in order to learn the time when the sugar becomes more prominent in its juice; to ascertain the rate at which this percentage increases, and to determine the particular point in the ripening process of the plant when the largest amount of sugar is present; and to notice finally the changes which the cane subsequently sustains in regard to the quantity and quality of its saccharine matter.

The results obtained from the cane raised upon the College farm led to the following conclusions: Grape sugar appears at an early stage in the growth of the

plant, and increases to three or four per cent. before the cane sugar is formed. The cane sugar is first noticeable when the flower-stalks begin to be visible above the leaves, and its amount increases until the seeds are of full size but still soft. The relative proportion of grape and cane sugars was generally about three to seven. The better quality of the juice in the later life of the plant is due rather to a loss of moisture than to the continued formation of sugar. The cane sugar changes gradually into grape sugar after the plants are cut.

The best way to secure the full benefit of the crop for syrup and sugar manufacture is to begin cutting when the seeds are full-grown but still soft, and to grind without delay. In the process of converting the juice into syrup, the relative proportion of the cane sugar and grape sugar was seriously altered, showing this plant to be unsuitable for the production of sugar. The average yield per acre was 160 to 170 gallons of syrup, which was yellowish in colour and somewhat peculiar in taste, though pleasant and quite generally liked.

Observations of the cane brought in from surrounding farms confirmed the conclusions drawn from the examination of the cane from the College field. The injurious changes which the cane undergoes after being cut were quite conspicuous. A trial made to see whether it would be better economy to grind the cane with the leaves or without, showed that the saving of labour in the field by omitting the stripping did not compensate for the loss suffered in the clogging of the mill and the waste of juice when the leaves were left on.

There followed a comparison of the expenses and returns in the case of the acre of the sorghum raised on the College farm, from which the conclusion was drawn that there should be a profit of $35 per acre. This surplus might be increased by an improvement in the yield which it would be possible to obtain, as in some instances the yield had been as high as 240 gallons of syrup per acre. He concludes: 'The presence of a large amount of grape sugar in all the later stages of the Early Amber, as well as of all other varieties of this species, is a serious feature in the composition of the juice, impairing greatly the chances for a copious separation of the cane sugar by simple modes of treatment. The necessity of applying more costly apparatus, and engaging skilled labour to secure the larger portion of the cane sugar, if once conceded, places the production of dry sugar from sorghum beyond the scope of general farm enterprise.'

The above conclusions have stood the test of time, for further attempts to utilize this plant as a commercial source of sugar have resulted in failure.

VII. CONTRIBUTIONS TO THE CHEMISTRY OF FRUIT CULTURE[1]

First Paper. (*Agriculture of Massachusetts*, 1879.) Dr. Goessmann opens the paper with a few general statements, bringing out the fact that the principles of fertilization, which had been studied for some time in the case of most of the farm crops, had not received attention as applied to fruits. Neither the chemical

[1] In co-operation with Samuel T. Maynard.

composition of the fruits themselves nor of the plants was definitely known, nor had the effect of different fertilizers been observed. Judging from past experience in general farm-management, it seemed wise to assume that much benefit may accrue to fruit culture, and horticulture generally, by studying the relations which exist between the composition of the soil and the ash constituents of the fruits grown upon it. Experiments, therefore, were conducted with grapes in the College vineyard, and the following subjects proposed for careful analytical investigation: —

1. What are the chief characteristic organic and inorganic constituents of the Concord grape as compared with those of the wild varieties of *Vitis labrusca* (L.), the vine from which the Concord originated?

2. To what extent is it possible to alter the quantity and relative proportions of the ash constituents in the fruit of both varieties; and, in case of such alterations, what are the changes which are likely to result with regard to their most characteristic organic constituents, such as sugar and acid?

He describes the method of carrying out the experiment, and gives the detailed analysis of the juice, wood, seed, skins, and pulp, stems and young branches. He found that the application of potash and phosphoric acid largely increased the amount of these two constituents in the ash, and was accompanied by an increase of sugar and a decrease of free acid.

Later, experiments were conducted in *girdling vines*, to secure definite data regarding the best methods to employ, and the effect of the practice on the vine and

fruit. The results of this investigation led to the following conclusions: —

The best results were secured when the cut was made between July 1 and August 1, and kept open by a second or third removal of the healing growth. If the first cut is made at least one-half inch wide, this second or third cutting may not be necessary, as it will not heal over so rapidly. No change was noticed in the vine or fruit below the point where the girdling took place. Vines girdled two years before retained their vigour. The only permanent effect noticed was the earlier ripening of the fruit from such vines. As the price obtained from grapes early in the season is several cents per pound higher than that received later, and as the grapes matured some two weeks earlier on the girdled vines, the practice was considered a profitable one. The grapes showed an increase in size over those grown on ungirdled vines, and were of practically the same chemical composition.

Experiments conducted to determine which of the buds — those nearest the main canes upon new wood, those in the middle of the canes, or those at the extremities — would produce the best bunches of grapes, showed that the bunches of grapes from the different buds were of nearly the same size.

Second Paper. Experiments with special fertilizers in fruit culture. (*Agriculture of Massachusetts*, 1884.) The paper begins with a short discussion of the desirability of studying the composition of fruits with a view of ascertaining the relations existing between the

kind and amount of available plant-food in the soil, and the relative and absolute quantity of the various soil-elements contained in the fruit raised upon it. The *absolute amount* of the mineral constituents in plants of the same variety may differ widely without changing the character of the plants; but a change in the *relative* proportion of the various mineral constituents almost always affects the quantity of some of the organic constituents, such as starch, sugar, acids, etc. This fact would seem to show that each of the various mineral constituents has a special function in the growth of plants. 'The more we learn of the specific functions of each essential mineral constituent of plants, the better will we be prepared to perfect our system of manuring; to cultivate with a view of developing desirable qualities in the crops, and to counteract the serious influence of an abnormal composition of the sap on the health of plants.'

He further describes an experiment with currants conducted at the College, in which these bushes, fertilized in different ways and unfertilized, were compared. From the analyses of the fruit it was evident that potash was the only ash constituent in which the soil was deficient. The addition of this element in every instance increased the percentage of potash in the fruit as well as the amount of vegetable matter and sugar. The colour of the berries was also improved. The increase of potash in the currant was invariably accompanied by a corresponding decrease of phosphoric acid, and of lime in particular, thus confirming his previous observations with other fruits. The most striking

alterations in the mineral constituents of the currant were produced by muriate of potash.

In the same article he gave a brief summary of his experience with the use of muriate of potash on peach trees suffering from 'yellows.' He believed this trouble to be due to an abnormal condition of the sap in so far as its mineral constituents were concerned, which resulted in the development of a fungous growth. He found that the cells in the young branches of the diseased trees contained an abnormally large amount of phosphoric acid and lime; the application to the soil of two to three pounds of muriate of potash per tree for two or three seasons reduced the percentages of these elements, and this reduction, together with judicious pruning, restored the tree to a vigorous growth.

The details of this experiment are given in the Second Report of the State Agricultural Experiment Station,[1] p. 105. The cause of peach yellows still remains a mystery, according to William H. Taylor, chief of the Bureau of Plant Industry, United States Department of Agriculture.

J. B. L.

[1] In co-operation with David P. Penhallow.

CHAPTER V

THE EXPERIMENT STATION

By act of the Legislature, the Massachusetts State Agricultural Experiment Station was established May 12, 1882, with a yearly grant of $5000 [1] for its maintenance, and Goessmann was made its Director and Chemist. He had persistently advocated the desirability of such an institution, and was exceedingly gratified at the final realization of his hopes. As time passed, his interest in the work of the Station increased and he gradually turned his college work over to others. Those who were associated with him in the early eighties will remember how continuously he discussed the present and future prospects of the Station.

He began at once to make plans for the future work of the Station. The Cowls barn was remodelled and fitted for the carrying on of experiments in feeding, plats were laid out for field experiments, under the supervision of Professor Manly Miles, and several small rooms were set aside in the College Chemical Laboratory for the chemical work of the Station. The fittings and conveniences of the laboratory were of the simplest kind, and office-room was not available.

The following principal lines of work were carried

[1] This amount was soon increased to $10,000 yearly, and later $500 were added. The National Government added to this support by the Hatch and Adams funds. It was not until 1913 that the State Legislature came to the support, with an additional grant of $5000 yearly for five years.

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out by Goessmann with the aid of assistants, mostly graduates of the Massachusetts Agricultural College, from the time he became director until he retired in 1907, and the results were published in the annual reports of the Massachusetts State Agricultural Experiment Station (1883-1894), and afterwards in the reports of the Hatch Experiment Station, in which the State Station was merged.

I. *The free analyses of fertilizer mixtures, agricultural chemicals, refuse materials and by-products suitable for fertilizing purposes, fodder-crops, concentrated feeds, dairy products — particularly milk — and drinking waters.*

Goessmann desired to make the Station of service to every one. He, therefore, accepted and had analyzed all materials of an agricultural nature that in his judgment would prove helpful to the citizens of the state. He gave freely of his time to reporting the results of the analyses and to answering all inquiries in his own handwriting; and one visiting him of an evening would find him often in his little office at his home, laboriously writing, with a pile of letters by his side. Even in his later years he would not employ a stenographer. He finally purchased a typewriter, and required one of the assistant chemists to learn the art of typewriting. He would then state to the young man the gist of what he wished to say in answer to letters received, and the assistant would write out the letter in full on the typewriter, to which Professor Goessmann appended his signature.

II. *The growing of soiling crops, the introduction of new soiling crops, and practical feeding experiments to test their merits.*

Goessmann was very much interested in animal nutrition. He had studied thoroughly the works of Grouven, Wolff, Henneberg, Stohmann, and their pupils, and was anxious to try out and put in practice their teachings. He recognized that the New England pasture was rapidly becoming inferior, due to neglect and to the oft-occurring summer droughts; and further that the hay crop was likely to decrease in amount and increase in price. In order to remedy these conditions he advocated the growing of a variety of summer forage crops, especially the legumes. He experimented with vetch, alfalfa, serradella, horse-beans, lupines, cow-peas, soy beans, and many others of less economical importance, most of which were new to this country. He also advised the growing of mixed fodder crops, that is, the mixture of a non-legume with a legume, recognizing that a larger yield frequently resulted than when these two crops were grown separately. In his judgment, a mixture of vetch and oats, and peas and oats was a very satisfactory combination. Other green crops which especially proved their worth from his point of view, were the soy bean, the cow-pea, and the serradella. He recognized in the lupines a valuable plant for soil-renovation.

In looking over the results of his experiments with green crops, one is impressed with the large variety of plants that he brought together for trial. In the writer's judgment, however, he did not succeed in

working out, or at least putting in workable form, a complete system of soiling that would prove practicable to the average farmer. Some of the crops which he advocated, while they possessed a high nutritive value, were too costly, because of the price of seed and labour involved in cultivation, to warrant their general use on the farm. At the same time, he brought to the attention of the agriculturist, and illustrated, the value of summer soiling and the variety of fodder crops which could be used to advantage for such a purpose.

III. *Feeding experiments with milch cows.*

A series of experiments, covering a period of five years (1885–1889), were conducted to compare the relative nutritive and economic values of such roughages as English hay, corn stover, corn silage, sugar beets, and carrots. The conclusions drawn were:

(*a*) The nutritive value of corn stover on the basis of dry organic matter compared well with an average quality of English hay; the same may be said of good corn silage fed in place of one-half the customary amount of hay.

(*b*) Carrots and sugar beets on the basis of dry organic matter have exceeded in nutritive value a like amount of silage when fed in place of one-half the hay.

(*c*) Corn silage and roots do best when fed in place of one-fourth to one-half the full hay ration. About 25 pounds of roots daily, or from 35 to 40 pounds of silage per day, with sufficient hay to satisfy the appetite, are about the correct proportions of roughage.

(*d*) Different rations appear to be without effect on the chemical character of the milk, this being governed by the constitutional characteristics of the animal.

(*e*) Milk is produced cheaper on corn stover and on silage than when hay constitutes the total roughage.

It must be remembered that Goessmann was quite without practical experience in animal nutrition when he began these experiments, and in the light of our present knowledge and experience his methods of experiment would be considered crude. He was a *pioneer*, however, and in spite of the methods followed, the above conclusions hold substantially true at the present time.

A second series (1887–1892), comparing on the basis of organic matter, green corn, green vetch and oats, peas and oats, cow-peas, soy beans, and serradella with English hay, led him to conclude that 'the nutritive effect was very satisfactory, for the animals without exception maintained their original weight; the yield of milk was in every instance somewhat raised, and the quality of the milk was equal to the best as far as one and the same animal was concerned.'

A third series with milch cows (1889–1892) was conducted to study the comparative nutritive values of such concentrates as new and old process linseed meals, cottonseed meal, Chicago gluten meal, maize feed, wheat bran, and corn meal. His conclusion was that the feeding value of the five first-named feeds did not vary greatly one from the other, but that the cost of producing a definite amount of milk depended to an extent upon the cost of these by-products, and particu-

larly upon the cost of the different roughages with which they were combined. He also called attention to the increased value of the manure where nitrogenous concentrates were fed in place of corn and other cereals.

IV. *Feeding experiments with pigs.*

Beginning in 1884 and terminating in 1892, Goessmann carried on 17 different feeding experiments with young pigs, to ascertain the best method of feeding, the most suitable feed-stuffs to use, and the cost of pork production. Usually six pigs were used in each experiment. At first, he compared the relative nutritive merits of skim milk and buttermilk, and found that on the basis of dry matter they had substantially equal nutritive values. Later, he investigated the most suitable proportions to be used of corn meal and skim milk, and in case skim milk was in limited supply, he endeavoured to find a suitable substitute in the form of different grain mixtures.

He started with young pigs of from 20 to 30 pounds in weight, and terminated the experiment when the individual animals reached a weight of from 180 to 200 pounds. Skim milk was in fairly liberal supply in the western counties of the state at the time, because of the numerous co-operative creameries engaged in the manufacture of butter.

As a result of these many experiments he advised the following combinations of milk and grain: —

I. WITH AN ABUNDANCE OF SKIM MILK

Live weight of animal	*Corn meal and skim milk*	*Nutritive ratio*
20 to 70 pounds.....	2 oz. meal to each quart of milk	1:3
70 to 130 pounds.....	4 oz. meal to each quart of milk	1:4
130 to 200 pounds.....	6 oz. meal to each quart of milk	1:5

II. WITH MILK IN LIMITED SUPPLY (4 TO 5 QUARTS DAILY)

Same proportions of meal and milk as in I, and a combination of grain in different proportions to satisfy appetites as follows:—

Live weight of animal	*Grain mixture (by weight) to supplement meal and milk*		
	Gluten meal	*Wheat bran*	*Corn meal*
20 to 70 pounds.....	2	1	1
70 to 130 pounds.....	1	1	1
130 to 200 pounds.....	1	1	2

He fed rations with a narrow nutritive ratio at first, when the young animal was in need of the largest proportion of nitrogenous matter, increasing the carbohydrates as the animal grew. A ration with a too narrow ratio after the animals have reached 100 pounds in weight retarded growth. He found it to be poor economy to keep the pig after it has reached a weight of 200 pounds. After that time the food-cost of a pound of growth was in excess of its usual market value. He presented very elaborate tables, showing the total amounts of feed consumed by each pig, the total dry

matter in the feed, gain in live weight, shrinkage in dressing, the amount of dry matter required to produce a pound of dressed weight, and the food-cost of a pound of live and dressed weight. The results of these various experiments with 140 pigs, and a number of later ones made by the writer, have been summarized by him in the *Eleventh Report of the Hatch Experiment Station*, pages 36–42.

V. *Feeding experiments with steers* (1889–1894).

Professor Goessmann undertook a series of experiments with grade Shorthorn steers to ascertain (*a*) the most suitable fodder rations; (*b*) the cost of beef production in New England; (*c*) the average daily gain in live weight; and (*d*) to compare the relative merits of summer soiling *versus* pasture.

The steers were, in some cases, sent to what was termed good pasture, and in other cases, soiled. During the seven autumn, winter, and spring months they were fed on corn fodder, corn silage, hay, and a variety of grains and by-products. In the writer's judgment the steers were not ideal ones for beef-production, although they were the best that could be found in the local markets. Well-bred blocky steers probably would have given rather better returns for the food consumed.

The results of these experiments are briefly stated:—

(*a*) The most economical coarse fodders consisted of corn fodder, corn silage, some corn stover, and minimum amounts of hay. The grains used at different times were wheat bran, cottonseed meal, gluten meal,

gluten feed, and linseed meal, selected naturally with reference to their market cost.

(*b*) The food-cost of producing a pound of live weight was 10.58 cents. The original cost of the steers and the total cost of food consumed was $817.50, and the selling price of the steers $460.91, leaving a loss of $356.59. A reasonable allowance for the manure would have been $161.00, still leaving a deficit of $195.59.

(*c*) The average daily gain in live weight for all steers was 1.24 pounds.

(*d*) In the case of the steers at pasture, the average daily gain was .63 pound, and in the case of the steers that were soiled 1.63 pounds. The steers made very poor gains at pasture, and it seemed evident that in order to secure satisfactory results ordinary pasturage must be supplemented with some roughage or grain. In spite of the additional daily gain when a system of entire soiling was followed, the cost of this method is likely to be prohibitive from the standpoint of economy.

VI. *Feeding experiments with lambs* (1890–1893).

Three experiments were conducted with 18 lambs dropped in the spring, and fed during the following winter and early spring months. Observations were made on the most suitable roughage and grains, and on combinations of the same for growth and economy.

The results secured were much the same as those secured for steers. The same feeds and feed combinations as fed to steers produced essentially the same

results when fed to lambs. The cost of the sheep and food at market rates, including a liberal valuation of the manure, about equalled the selling price of the lambs. It is probable that, figured at present prices, the returns would be more favourable. At that time, however, there did not seem to be any direct profit in growing yearling lambs. The only advantage seemed to be the selling of roughage at market rates and the securing of a valuable manure for crop production. The data secured by Goessmann were interesting and valuable.

VII. *Fodder corn raised upon worn-out meadow lands partly fertilized with one or two special articles of plant-food and partly without the use of any manurial matter* (1883–1888).

The object of this experiment was to ascertain if land that had been for a long time cropped with grass and corn — the usual method of rotation practised by many farmers at the time — was suffering from general or special exhaustion. The one and one-tenth acres used for this purpose were divided into one-tenth acre plats and known as Field A. During 1883 and 1884 the land was planted with corn without the application of any form of plant-food, and showed unmistakably pronounced evidence of general or special exhaustion. Beginning in 1885, different single articles of plant-food were applied — nitrate of soda, ammonium sulphate, dried blood, dissolved boneblack, muriate of potash, and sulphate of potash-magnesia. There were three nothing plats and one fallow plat. At the close

of the experiment in 1888, the following facts were clearly in evidence: —

(1) The soil was found to be especially deficient in available potash as a result of the continued close rotation of grasses and corn.

(2) The plats to which potash only was applied responded readily with increased yields. After three years these plats began to show a decided shrinkage in crop-production and more complete fertilizers were needed to maintain the yield.

(3) Allowing land to be fallow does not materially benefit its productiveness, and should be discouraged. (Photographs of the yield on the different plats appear in the sixth report of the Station.) The above experiment was considered at the time a very striking illustration of the exhaustion of available soil potash by the continued cropping with grass and corn.

VIII. *Field experiments to compare the influence of an addition of nitrogen in different combinations to the soil under cultivation on the general character of the crop and the annual yield* (1889–1892).

The same field (A) which was used for the previously described experiment was employed in the present case. All of the 11 plats received an equal amount of potash in the form of muriate or double sulphate of potash and magnesia, and of phosphoric acid as dissolved boneblack. The nitrogen was supplied in the forms of barnyard manure, nitrate of soda, sulphate of ammonia, and dried blood. Three plats did not re-

ceive nitrogen in any form. The crops grown were corn, oats, rye, and soy beans.

The results of four years' observation showed quite clearly that the application of some form of nitrogen was necessary in order to secure remunerative crops. Even soy beans, a nitrogen gatherer, did not take sufficient air nitrogen to produce a normal yield. The fallow plat, after several years' cultivation, was still behind the other plats in crop yield. Beginning with 1893, and continuing through 1896, a legume (soy beans) was alternated with a non-legume (oats), to note if the frequent cultivation of a legume would gradually increase the available nitrogen in the soil so that it would not be necessary to apply fertilizer nitrogen. At the close of the experiment in 1896 it was observed that the 'introduction of an annual leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it.' The plats at that time which had not received any nitrogen proved one-seventh to one-eighth less productive than the others. After 1896 advancing years made it necessary for Professor Goessmann to discontinue his field experiments. This experiment was continued by Brooks, and further information will be found in the ninth and later reports of the Hatch Experiment Station.

IX. *Experiments with potatoes* (1884–1888).

This experiment was undertaken originally for the purpose of studying the effect of muriate and double

sulphate of potash-magnesia on the quantity and quality of potatoes. Before the experiment had been in progress long, a scabby condition of the crop resulted, which led to a study of the cause of this trouble. Goessmann states that 'neither a liberal use of our own mixture of commercial manurial substances rich in potash compounds nor the selection of a fair quality of seed potatoes from another locality had affected our results; . . . for the entire crop with scarcely any exception was badly disfigured by scab.' The conclusions were as follows: —

(1) Medium-sized whole potatoes give better results as far as a large-sized marketable crop is concerned than half potatoes obtained from tubers of a corresponding size.

(2) The sulphate of potash produced better results than muriate of potash.

(3) Some peculiar condition of the soil is considered the real cause of the scabby condition. (Photographs of the scabby potatoes are given in the sixth report of the Station, page 131.)

It is evident that this scabby condition seriously interfered with the experiment as originally planned. It led to observations on the cause of the scab, and to the conclusion that the seat of the trouble lay in the soil. Later investigations by botanists showed it to be a parasitic organism.

X. *Experiment with root crops* (1887–1888).

A brief discussion is given of the general character of roots and their place in the farm economy. Seed was

obtained from the United States Department of Agriculture, of several varieties of mangolds, sugar beets, turnips, and carrots. They were grown upon the Station grounds, observations recorded of the methods of cultivation, photographs taken and published of the more promising varieties, and detailed chemical analyses were made and published.

XI. *Experiments to study the economy of using different commercial sources of phosphoric acid for manurial purposes in farm practice* (1890–1897).[1]

The soil had been in grass for a long time, and its supply of available plant-food had become greatly reduced. During 1887–1888–1889 it was planted with crops to still further exhaust the phosphoric acid. The field was divided into five plats, a definite amount of the same form of nitrogen and potash added, and five different sources of phosphoric acid applied on the basis of their market value, namely, 127 pounds of basic slag, 128 pounds of Mona guano, 304 pounds of apatite,[2] 131 pounds of South Carolina phosphate, and 78 pounds of dissolved boneblack. On the basis of one acre, such applications were at the rate of 850 pounds for slag, Mona guano, and South Carolina phosphate, 2000 pounds of apatite, and 500 pounds of boneblack. In 1894 and thereafter the phosphoric acid application

[1] Goessmann discontinued this work with the season of 1896, and it was brought to a conclusion in 1901 by Brooks.

[2] In 1891, apatite could not be secured, hence phosphoric acid was not applied to this plat. In 1892, 129 pounds of Florida hard phosphate were substituted — equal to 850 pounds per acre. It could not be considered fair to this phosphate to compare it with others which had been applied two years longer.

was omitted in order to get the residual effect, while the supply of nitrogen and potash was increased one-half.

The crops and yields in the several years were as follows in pounds: —

Fertilizer	1890 *Potatoes*	1891 *Wheat*	1892 *Serradella*	1893 *Corn*	1894 *Barley*	1895 *Rye*	1896 *Soy beans*
Basic slag	1600	380	4070	1660	490	695	254
Mona guano	1415	340	3410	1381	405	630	233
Florida phosphate	1500	215	2750	1347	290	383	262
S.C. phosphate	1830	380	3110	1469	460	759	252
Dis. boneblack	2120	405	2920	1322	390	625	247

TOTAL PHOSPHORIC ACID ADDED AND REMOVED
1890–1896

Fertilizer	*Amount added (pounds)*	*Amount removed (pounds)*	*Per cent removed (pounds)*
Basic slag	96.72	31.11	32.17
Mona guano	72.04	27.81	38.60
Florida phosphate	165.70	23.98	14.47
S.C. phosphate	144.48	29.46	20.39
Dis. boneblack	49.36	27.57	55.85

As a result of these observations Goessmann concluded that for the first two years the dissolved boneblack led, while afterwards the insoluble phosphates were ahead in the following order: basic slag, South Carolina phosphate, and Mona guano.

On the basis of money value, Goessmann's conclusions appear correct; on the basis of phosphoric acid applied and removed, it is shown by the preceding table that dissolved boneblack led, followed by Mona guano, basic slag, South Carolina phosphate, and Florida phosphate. Brooks sowed Swedish turnips in 1897, and found that the Mona guano produced by far the largest yield.

It may be remarked that this experiment was faulty in that (*a*) no check plat or plats were included from which the phosphoric acid had been omitted; (*b*) the ceasing to apply the various phosphates after 1894 was unfair to the dissolved boneblack when the results are based upon crop-yield, it being necessary in order to secure the best returns to apply relatively small amounts of the soluble phosphates each year; (*c*) the application of definite amounts of phosphoric acid as above stated would have been preferable to money value in judging the relative effects of the several forms as sources of plant-food.

XII. *Experiments with grass-lands to determine the effects of different forms of plant-food on permanent meadows* (1889–1895).

The moist meadow on the east side of the county road was underdrained and divided into four plats. Plat I contained 1.92 acres; Plat II, 1.92 acres; Plat III, 2.41 acres; and Plat IV, 3 acres.

The first two plats received barnyard manure at first in different amounts, to ascertain its limit of usefulness. In 1892 Plat I received at the rate of

8 tons and Plat II at the rate of 6 tons of manure per acre.

Plat III received 600 pounds of fine ground bone and 200 pounds of muriate of potash per acre.

Plat IV received one ton of Canada ashes per acre.

In 1893, Plats I and II were combined and used as one plat. Beginning with this year also a system of rotation in manuring was instituted, Plats I and II receiving wood ashes, Plat III barnyard manure, and Plat IV bone and potash. This same system was continued in 1894. In 1895, another rotation of the same manures was instituted. At the close of this year Plat I, which had received manure for most of the time, had averaged at the rate of 3.56 tons; Plat III, 3.25 tons; and Plat IV, 2.90 tons of hay to the acre. These experiments were continued by Brooks. After the plats had been in grass ten years, Brooks stated that since 1893, during the continuance of the rotation system of manuring, the field had averaged 3.4 tons of hay and rowen per acre. The plats when dressed with manure averaged 3.6 tons, with bone and potash 3.33 tons, and with ashes 3.27 tons per acre. Brooks further says that 'this system of using these different manures for grass lands in rotation has much to commend it. It is simple and has given remarkably good crops.' The writer remarks that it shows what natural grass-land can be made to produce when fairly well fertilized each year. Moisture and plant-food are the controlling factors in hay production.

XIII. *Field experiments regarding the effect of different combinations of commercial fertilizer on the yield of some prominent garden crops* (1892–1897).

Six plats of one-eighth of an acre each, known as Field C (each 88 x 62 ft.), were laid out and treated with 50 pounds of phosphoric acid in the form of dissolved boneblack, 60 pounds of nitrogen in the forms of nitrate of soda, sulphate of ammonia, or dried blood, and 120 pounds of potash in the form of muriate or high-grade sulphate.

The object of the experiment was to test dried blood, nitrate of soda, and sulphate of ammonia, combined with muriate of potash and high-grade sulphate of potash.

A number of rows of each of the following crops were planted on each plat during the several years: celery, lettuce, spinach, beets, cabbages, tomatoes, potatoes, beans, onions, corn. In 1894–1895–1896, onions, sweet corn, beans, and tomatoes constituted the crops grown.

As a result of his observations through 1896, he draws the following conclusions: —

(1) Sulphate of potash, with nitrate of soda, has given in every case (excepting onions) the best results.

(2) Nitrate of soda as a nitrogen source has yielded in almost every case, without reference to the source of potash, the best results.

(3) Sulphate of ammonia and muriate of potash have given, as a rule, the least satisfactory results. The fact is due evidently to the change of chloride of potash and sulphate of ammonia into sulphate of potash and

chloride of ammonia, the latter being an unfavourable form of nitrogen plant-food. The above was not positively demonstrated but only assumed. It may have been the case, however.

(4) The influence of the weather, particularly the rainfall . . . has been greater than that of the different fertilizers upon the different plats during the same season. It was evident that the lack of moisture played a very important rôle in the yield of the several crops. This experiment was continued on the above plan through 1897, by Brooks, who drew substantially similar conclusions to the above. Beginning with 1898, it was modified. (*Eleventh Report of the Hatch Experiment Station*, page 67.)

XIV. *Field experiments to compare the effect of barnyard manure with Canada ashes and mixtures of commercial fertilizing materials on farm crops* (1888–1894).

The land for this experiment was situated east of the county road, bounded on the north by 'Lovers' Lane,' so-called, and on the east by woods. It was to the east of the meadow used for experiments with grass. Five plats of substantially nine-tenths of an acre each were used, divided by strips 14 feet wide. The land had been in grass previously, but in 1888 was ploughed and fertilized with ashes. The only difference in the treatment of the five plats consisted in supplying different forms of plant-food as follows:

Plat I — 10 tons barnyard manure per acre,
Plat II — 1 ton Canada ashes per acre,
Plat III — without fertilizer,

Plat IV — 600 lbs. ground bone and 200 lbs. muriate of potash per acre,

Plat V — 600 lbs. ground bone and 400 lbs. double sulphate of potash-magnesia per acre.

The following crops were grown during the several years: barley, oats, dent corn, vetch and oats, Scotch tares, soy beans, Canada peas, and oats. Several crops were planted as a part of the same plat in each year, the conditions on all of the plats being uniform.

As a result of these observations, the following general deductions were drawn: —

(1) In 1890 the effect of bone and different forms of potash compared very well with stable manure, as did also Canada ashes. Part of this favourable effect Goessmann ascribes to the organic matter in the soil derived from the sod turned under in 1888.

(2) Sulphate of potash-magnesia has given rather better results than the muriate with legumes.

(3) The yield of the unfertilized plat in 1891 showed a noticeable decline as compared with the fertilized plats (one-third less).

(4) Seeding in drills in all cases gave a larger yield of grain than seeding broadcast.

(5) Muriate of potash seems to produce larger yield in case of grain crop.

(6) Soy beans should be planted in drills, otherwise they are interfered with by weeds.

(7) Vetch and oats yield larger crops earlier in the season than soy beans. They also yield a larger crop of dry fodder for winter use.

(8) Both vetch and oats and soy beans make a valuable ensilage. Two parts, by weight, of corn and one part of beans are desirable proportions.

In 1890 Goessmann began to set out the above five plats to fruit trees — apples, pears, and peaches. Plums were added in 1893, and in the autumn of that year the plats were seeded to rye and grass. After that, these plats were treated as an orchard. The experiment was continued by Brooks, and eventually the apple trees only were allowed to remain. The apple trees are now full grown, and the experiment has yielded valuable information which has been reported by Brooks in the later reports of this Station.

XV. *Field experiments with tobacco in Massachusetts.* (Bulletin No. 47, Hatch Experiment Station, 1893–1896.)

These experiments were carried on in Hatfield, Westfield, and Agawam in co-operation with the so-called Valley Tobacco Experiment Association. Expert tobacco-growers had special supervision of the experiments in each of the three towns. Twelve plats, each one-twentieth of an acre, which were laid out by a representative of the Station, served for the trial. Potassium oxide was applied at the rate of 300 pounds, available phosphoric acid 60 pounds, and nitrogen 100 pounds to the acre. One-fourth of the nitrogen was in the form of nitrate of soda and potash.

The crop was cut, housed, and stripped under expert supervision.

Among the many conclusions drawn may be mentioned the following: —

(1) A careless use of cultivator or hoe checks growth of plants and modifies their structure and general character.

(2) Different fertilizer combinations have had less effect upon the quantity than upon the quality of the crop. New land naturally suited to tobacco and cropped for a number of years to exhaust the available plant-food, served much better for the experiment than land upon which tobacco had been continuously grown and which had been heavily fertilized.

(3) Cottonseed and linseed meals and castor pomace all proved equally desirable sources of nitrogen when used in connexion with nitrate of soda or potash.

(4) Nitrate of soda, used together with acid phosphate or dissolved boneblack, proved more satisfactory than nitrate of potash.

(5) Cottonseed hull ashes and high-grade sulphate of potash proved the most valuable potash sources, the former being preferred in most cases. Nitrate of potash was very satisfactory when used in combination with an alkaline phosphate such as basic slag or with carbonate of potash-magnesia. Sulphate of potash-magnesia did not give satisfactory results.

Other interesting observations concerning the probable effect of fertilizers on colour of ash, observations with barnyard manure, etc., will be found in the bulletin.

XVI. *Compilation of tables of analyses of fertilizer chemicals and fertilizer by-products, cattle feeds, dairy products, and fruits.*

The chemists of the Experiment Station were always busy, and as time passed a very large number of analyses accumulated. In 1887, in order to make them more readily available, Goessmann made his first tabulation, which included all analyses made since 1868. These compilations have been continued by the writer and his co-workers with such modifications and enlargements as circumstances advised.

XVII. *Water analyses.*

Free analyses of drinking water were made as early as 1883. In the second report of the Station he dwelt upon the importance of pure water upon the farm. The analyses made from year to year indicated frequent contamination, both from sewage and from the use of lead pipe. Each year a large number of samples were received from different citizens of the state, and in 1903, because of an abuse of the privilege, a small charge for an analysis was imposed and the water was required to be shipped in containers supplied by the Station.

XVIII. *Meteorology.*

Beginning in 1883, a systematic record was kept of the weather, including temperature, wind, humidity, and rainfall. One of the assistant chemists was especially charged with this work. In his first report he says: 'The importance of meteorological data in connexion

with observations upon plants and animals is apparent to all. No conclusions are firmly grounded until the conditions of temperature, moisture, and sunlight have been duly considered.' Similar or more complete observations were continued after the Massachusetts Station was merged in the Hatch Station.

XIX. *Miscellaneous work.*

In addition to the work already reviewed, many other experiments were made and reported which were of value at the time. Among these may be mentioned temperature conditions in the silo for several weeks after filling, a continuation of his observations on the effect of different forms of potash in fruit-culture, a study of the conditions in two local creameries, and the composition of the milk of different breeds of cows.

As a conclusion to the brief review of the scientific papers and the experiments undertaken by Goessmann from the beginning of his connexion with the Massachusetts Agricultural College in 1868 until his retirement in 1907, one cannot fail to be impressed with the wonderful energy displayed by him. He was not a rapid worker, but he succeeded in accomplishing much because of his steady and long-continued application. He took comparatively few vacations. He possessed a strong constitution and a phlegmatic temperament. His pleasant home life, together with his garden, his shrubbery and trees, were his constant sources of recreation and enjoyment. Vacations were to him in reality more a duty than a pleasure. He did practically

no chemical work himself after he became director of the Station, devoting all his time to executive work, including correspondence, and particularly to studying the work of foreign investigators.

While he did not possess any practical agricultural experience previous to coming to Massachusetts, he studied thoroughly the agricultural conditions of the state in order to see just how the College and Experiment Station could be of most use to the farming interests. In all his lines of work, his aim seemed to be not so much to study fundamental problems in agricultural chemistry as to show how chemistry could be applied to help improve farm operations.

Thus, in animal nutrition he endeavoured to illustrate the need of a greater diversity of coarse fodders, and the special value of the legumes; to show by actual feeding trials the value of the rapidly increasing number of concentrated protein by-products. In his feeding trials with pigs, steers, and sheep, his object was to show the farmer how best to utilize the by-products of the dairy and the roughages of the farm in order to produce pork, beef, and mutton with the greatest economy. In addition to applying the principles of animal nutrition as they were known, his constant thought was that of economy in the feeding of animals, the getting of data that would show the farmer the cost of producing a definite amount of animal products.

In experiments in the field his object was first to secure data on the general chemical composition of different soils; to note if a failure to produce crops was

due to general or special depletion of fertility; to observe the relative values of different forms of the most important elements of plant-food and their effect in improving the growth of different farm crops. For example, he sought to ascertain the value of different forms of phosphoric acid, nitrogen, and potash, and their specific effects on the yield and, whenever possible, upon the quality of fodder crops, vegetables, and fruits.

He used the chemical laboratory, not so much to study fundamental chemical problems, as to ascertain the proximate chemical composition of soils, of fertilizers and by-products having a manurial value, of cattle feeds, dairy products, fruits, and vegetables. Such data were very scanty at the time and it was necessary to secure them as a basis for future work.

In addition to descriptions of his own experiments, one finds in the various reports of the Experiment Station brief papers explaining the scientific principles underlying the subject. He had read thoroughly the works of the German, French, and English investigators, and he was thus able to present to his readers the most advanced views of the day on the problem under consideration.

One can readily see that the many practical problems confronting him on every side, together with the lack of appreciation of strictly scientific inquiry by many of the farmers of the day, prevented him from undertaking any very fundamental research work. He was of necessity a pioneer in the cause of agricultural investigation. If, at the present time, at the age of

thirty, he had come to this country with a relatively similar training to that which he possessed in 1857, he undoubtedly would have attacked and solved some of the more intricate agricultural problems now confronting us. He was contemporary with Hilgard of California, Johnson of Connecticut, Cook of New Jersey, and Kedzie of Michigan, all of whom greatly widened the horizon and enriched our knowledge of agricultural science and practice.

J. B. L.

CHAPTER VI

LATER YEARS

On the 28th of July 1880, Dr. Goessmann attended a convention of the leading agricultural chemists of the country at Washington. At this gathering he offered the following resolution, which was adopted: — 'Resolved, That this Convention form a section in the subdivision of Chemistry of the American Association for the Advancement of Science, and that the next meeting be held in Boston, during the regular meeting of the aforesaid Association.' A permanent organization was then effected under the name of the Association of Agricultural Chemists,[1] and Dr. Goessmann was made chairman. Goessmann's reputation as a technical and agricultural chemist had long been firmly established, and his election to this office was a fitting recognition of his services and contributions to those branches of chemical science. Earlier in the year he had been unanimously elected State Chemist of North Carolina, to fill the vacancy occasioned by the resignation of Dr. Albert R. Ledoux. This position, however, he had declined.

In 1881 and 1882 he served as a member of the committee appointed by the National Academy of Sciences to investigate and report on the scientific and economic

[1] Reorganized, September 8, 1884, as the Association of Official Agricultural Chemists of the United States.

relations of the sorghum-sugar industry in the United States. Averse to controversy, and rather than risk being entangled in disputes, — so little to his taste, — he finally withdrew from the committee. From 1883 to 1904 he was analyst to the State Board of Health of Massachusetts, and from 1886 until his death chemist to the Bay State Agricultural Society.

He was a member of several of the leading scientific societies and academies, both at home and abroad. Some of these have already been mentioned and others will be found in the Chronology. In 1865 he was elected a corresponding member of the New York Academy of Sciences. In 1869 he joined the American Association for the Advancement of Science, and in 1875 was elected a fellow. One of the original members of the American Chemical Society, founded in 1876, he was a vice-president in 1877, and again in 1881 and 1882. In 1887 he succeeded Dr. Albert B. Prescott as president. In 1880 he was one of a committee of three appointed to represent the Society at the centennial celebration of the American Academy of Arts and Sciences. He was also a member of the general committee of arrangements for the twenty-fifth anniversary celebration of the Chemical Society in 1901.

Goessmann was one of the twelve scientists who, at a meeting held in Boston in April 1880, organized the Society for the Promotion of Agricultural Science. In 1893 he was a member of the Advisory Council on Chemistry of the World's Congress Auxiliary of the Columbian Exposition, and was invited to address the

Congress of Chemists at Chicago on *salt*, on *methods of teaching or demonstrating chemistry*, and on *the progress of chemistry as applied to agriculture*. In 1889 Amherst College conferred upon him the degree of Doctor of Laws.

He was a frequent lecturer before the state boards of agriculture and the various agricultural and horticultural societies, and read papers at the meetings of the American Chemical Society and other scientific bodies. For upwards of thirty years he was a constant attendant at the gatherings of the Massachusetts State Board of Agriculture and the most constant contributor to its reports. He lectured before the Board 'on salt and its uses in agriculture'; 'on nitrogen plant-food'; 'on the subduing and utilizing of salt-marshes for tillage'; 'on plant and animal nutrition'; 'on the chemistry of fruit culture'; 'on the cultivation of the sugar-beet'; 'on the effect of chemical salts on the carbohydrate content of plants'; 'on the system of preserving green food in silos'; 'on mineral constituents in plant-growth'; 'on the influence of chemistry in the development of a rational system of stock-feeding'; 'on the rotation of crops'; 'on rational fertilization of garden crops and fruits'; 'on the hay-field and English hay'; 'on the breeding and feeding of swine'; and 'on the grass crop.'

On November 12, 1898, a notable dinner was given at the Metropolitan Club in New York, for Göttingen students of 1855–56, with some of earlier and later dates, the hosts being Mr. J. Pierpont Morgan, Professor Charles F. Chandler, and Mr. James D. Hague.

Dr. Goessmann attended this 'Reunion of Companions at Göttingen,' and was one of the speakers. At this interesting gathering were many of his old pupils and friends, including Caldwell, Chandler, J. H. Eastwick, Hague, Hungerford, Magee, Mallet, and Tuttle. Of the ten whose names are inscribed on the balance presented to him in 1855–56, six of the seven then living were present. Dean, Nason, and Pugh had passed away.

In August 1899 Dr. Goessmann, accompanied by his wife and daughters, revisited the Fatherland after an absence of more than forty years, remaining abroad until the following summer. This was his first vacation for thirty years, or since the call to Amherst in 1868. He went also as an honorary representative of the United States Department of Agriculture, to investigate the condition of the beet-sugar industry in the German Empire. He was likewise a delegate of the American Chemical Society to the unveiling of the statue of Antoine-Laurent Lavoisier in Paris. He went, however, with the intention of doing but little scientific work, and finding pleasure among friends old and new.

He spent nine delightful weeks in Göttingen, making various excursions in the neighbourhood, especially to beet-sugar factories and beet-raising farms. With the professors he had much pleasant intercourse, among others his old colleague Friedrich Griepenkerl, then dean of the philosophical faculty. He enjoyed also the hospitality of the Fräulein Helena and Sophia Wöhler, daughters of his beloved teacher. Fifty years had

passed since he matriculated as a student of pharmacy and chemistry in the philosophical faculty of the University of Georgia Augusta, and forty-eight since he took his degree as Doctor of Philosophy. It is the German custom to renew that degree for those that survive fifty years. To him those weeks at Göttingen were an occasion of quiet rejoicing, and he often referred to 'Göttingen revisited' as his *Jubilæum*.

From Göttingen he wrote: —

'In looking over the collections of inorganic and organic chemical preparations in the chemical laboratory my attention was repeatedly called to samples familiar to me from the time when acting as assistant to Wöhler. It seemed to give special satisfaction to the janitor, who served as a youthful janitor in my time, to point out to me specimens marked in my handwriting.'

He returned to America the following June, and was soon again occupied with his work, aware that the students, whom he had gathered about him and trained, were capable of taking up the lines whenever he should lay them down. He continued to supervise the chemical work of the Experiment Station until July 1907, when he was made Consulting Chemical Expert and retired on a pension granted by the Trustees of the Carnegie Foundation. In 1908 he became Professor *Emeritus*.

On his eightieth birthday, which marked the completion of fifty years residence in the United States and forty years of service at the College, his former students far and near united to honour him. At the

Alumni dinner in Draper Hall, on June 17, 1907, he was presented with a highly decorated stained window, to be hung in his study, on which is written: —

To
KARL ANTON GOESSMANN
of Naumburg Fritzlar and Göttingen
Chemist Teacher Philosopher
this testimonial
commemorative of forty years of loyal and fruitful service
at the Massachusetts Agricultural College
is presented by his pupils
on his 80th birthday
13 June 1907

As reminders of the old home places, the armorial bearings of Fulda, Fritzlar, and Göttingen are emblazoned, quartered, on one shield; the silver cross of the old arms of Fulda and the lilies of the new; the cross and wheels of Fritzlar and the towers of Göttingen. The seal of the University of Göttingen is on the right, with Minerva, the Goddess of Wisdom, her back toward the spear and the shield bearing the masque of war and facing the emblems of peace — the olive-branch and the open book. The German chevron is depicted in red, white, and black — the royal and imperial colours. The background shows the Hanoverian colour — yellow — which also is that of the University. Below are the emblems of the chemist, the flames of his fire surrounding a Hessian crucible, a retort in ancient form, a blowpipe, assayer's tongs, and before the furnace are test tubes. The blue and the green of the Wistaria are interspersed with the foliage of the *Arachis* or peanut plant and the yellow of its flower, to

recall one of his earlier investigations. While at Göttingen he studied the oil of the peanut, the fruit of *Arachis hypogaea*, in which he found two acids until then unknown, and which he named 'arachic acid' and 'hypogaeic acid' respectively. The luxuriant growth of these vines symbolizes the rich harvest due to his labours with fertilizers. And above is written the old Göttingen motto, '*Die Göttinger haben den Muth*' (the Göttingers have courage). The expression originated at the time when the inhabitants of the walled town successively and successfully repulsed the robber barons of the region when on their plunder raids. The window was unveiled by Dr. Charles Wellington, his colleague in the Chemical Department for a quarter of a century, and was accepted by Dr. Goessmann with a few dignified and touching words.

In January 1910, at the request of the Alumni, he sat for his portrait to Mr. Edwin B. Child of New York. At the Alumni dinner on the 21st of June following it was unveiled by Frederick Tuckerman and presented to the College. The portrait was accepted, on behalf of the Trustees, by Mr. William H. Bowker of Boston, a member of the first class and the senior member of the Board. Many addresses were made by his former students and others. Much to his regret Dr. Goessmann was unable to be present, but a letter from him was read by Dr. Homer J. Wheeler, the President of the Association, in which he sent his 'affectionate greeting and best wishes' — his last earthly message — to his 'old pupils.'

Pre-eminently a domestic man and a devoted hus-

band and father, his chief delight was in his home. It was interesting to witness his childlike pleasure in his beautiful grounds, in the trees and shrubs — all selected and planted by him with excellent taste. In tending and caring for them he found abundant relaxation and recreation.

Deeply religious from his youth, the contemplation of Nature, no less than the sublime teaching of Scripture, inspired him with true devotion. He spent much time in meditation and the study of the Bible. He greatly admired the works of Faber and Newman, and their writings formed part of his daily reading. Born a Catholic, the faith of his fathers, he lived and died a devout member of the Church. It was largely through the joint and persistent efforts of Dr. Goessmann and his devoted wife that a Roman Catholic church was built and maintained in Amherst.

He was taken ill on the 23rd of August. He lingered until the 1st of September, retaining his mental faculties clearly until the last, — serene in his beautiful and firm faith, — and soon after noon of that day passed quietly away. On the 5th of September he was buried from St. Bridget's Church, and his remains lie in the little cemetery at Plainville.

An impressive and most appropriate service in memory of Dr. Goessmann was held in the chapel of the Massachusetts Agricultural College on Wednesday morning, October 12, at which addresses were made by President Butterfield, Professor Chandler of Columbia University, President Stone of Purdue University, and Professor Wellington of Amherst. The

service was closed by the Rev. Dr. Cummings of Holy Cross Church, Holyoke, who offered prayer and pronounced the Benediction.

Goessmann was a teacher in a wide sense. He not only taught his pupils in the class-room and laboratory, and trained his assistants, but he made the College the nursery of agricultural chemists for other institutions throughout the land. By his lectures and talks, his reports and bulletins, he taught and educated the public. In the lecture-room and laboratory he was painstaking and inspired his students to grasp the problems he set before them. As an experimenter he had readiness and skill, and could attain important results with the minimum possible means. No one who came in contact with him could fail to be struck with the accuracy and extent of his knowledge and the retentiveness of his memory. But he was more to his pupils than a friend and teacher. He was the 'Beloved Goessmann' — the object of their admiration and affection on account of his goodness, gentleness, modesty, and patience, his high principle, his unfailing cordiality, his unceasing interest in their welfare, and the clearness of his intellectual vision. He was a fine example of the Christian philosopher.

At Göttingen he devoted himself to the discovery of new truths. After he came to America the *utility of science*, especially in his chosen field, was always uppermost in his mind. He was always tracing abstract principles to their practical applications, and thus bringing scientific knowledge within reach of the farmer and the general public. Quick to read the signs of

the times, he had a clear comprehension of the actual conditions and the needs of chemical education in this country.

He lived to see the most remarkable changes in the science which he had himself so successfully cultivated. But like his great master, he preferred demonstration to speculation; and although ready to adopt what was established by experiment, however it might conflict with his previous views, he was strongly opposed to innovations based upon mere hypotheses. His profound love of truth made him the cautious, painstaking, persevering inquirer he was. He was a student of facts. Like Faraday, he could 'trust a fact.' He searched for *facts* and taught their value. He cared rather to gather them than to deduce from them general laws. Slow to generalize, in his judgments he was conservative and independent.

Admirably fitted by tradition, training, experience, and temperament for the life of a teacher and investigator, he brought to the service of the College a singularly happy combination of qualities — genuine devotion to his subject, great capacity for work, the power to kindle enthusiasm in others, a well-balanced mind and body, and a robust physique. In the retrospect of his life one is struck with the amount of labour which he performed. Always at work, never in haste, systematic beyond most men, perfect order pervaded all that he did. In his speech he never wholly lost his foreign accent and German idioms. Yet as a writer he had a good style and wrote English with facility and ease, — with scarcely a trace of the involution of his

mother tongue, — expressing himself in clear and forceful language. His writings show the clear thinker and the well-stored head. His researches embrace a wide range in chemical science, and in analytical, technical, and agricultural chemistry are marked by high attainment. He was not a writer of books, yet in total amount of production, if not in variety and depth of interest, he may fairly be compared with Noah Webster and President Hitchcock, unquestionably the two most fertile writers Amherst has known. His first contribution to chemical science appeared in 1853, and thereafter an uninterrupted series of contributions to chemistry flowed from his pen for fifty-four years. They remain an enduring monument to their author.

LETTERS OF FRIEDRICH WÖHLER

FRIEDRICH WÖHLER

GÖTTINGEN, 3 *January* 1858.

DEAR DOCTOR,—

Your kind and interesting letter of December 3 reminds me that I have not yet answered your first one of June 26. Therefore, I must not delay any longer, though I must admit that I have nothing to say that is worth sending across the ocean. I thank you heartily for all your communications, which I have read with great interest, and which fully confirm the impressions I have received of life and conditions in the new world. I need not tell you that the news of your pleasant voyage and safe arrival has pleased us more than anything else. For a journey of that kind, compared with a journey from here to Fritzlar, must always be considered a venture. It pleased me also to hear that your new sphere of activity meets your expectations. Still, owing to Eastwick's promises and considering your own trustworthiness and sense of honour, I never had any doubts about the result. At all events you are to be congratulated on having made and carried out this resolution, for there is no doubt that a sojourn in America is going to have the greatest influence upon your whole future life, even though you do nothing more than endeavour to acquire the good qualities for which the Americans are noted, their perseverance, self-reliance, their spirit of enterprise — all qualities that so often fail in us Germans. And then, the oppor-

tunity to take a broader view of the world by studying men and conditions on a great scale. In particular, I congratulate you on your success in your new field, and having at this early stage improved upon the method of refining sugar. Not being familiar with the regulations governing patents, I am unable to judge of the merits of your process. I am inclined to think that it would be easier and more to your advantage to sell your process to individual factories. In this I shall do all in my power to assist you. First of all you might apply to Hurtzig.

Respecting the new sugar plant, I have notified Kopp by sending him the main points of your letter, noting also that you intend sending the seed. Not until after reading your exhaustive monograph concerning this research can I judge of its adaptability for publication in the *Annalen*. Meanwhile, I am in favour of it, provided it is not too detailed and technical. This matter seems to me to be of great importance, provided the plant can be raised in Germany and other countries. In the latter case you will have the distinction of having introduced it into Germany.

Here everything remains unchanged. Limpricht, Geuther, and Wicke send their greetings. Wicke has become professor extr., Limpricht and Boedeker assessors at the University Society. Deville was here again in the autumn. I am enclosing the results of our last researches.[1] I presume you have seen in the *Annalen* the paper on the new silicium compounds by Buff and myself, as well as the experiments with titanium. Deville and I have now succeeded in producing a nitro-

[1] '*Neue Beobachtungen über das Bor und einige seiner Verbindungen.*'

gen-silicium having the same behaviour as nitrogen. Probably you have heard of little Engelhardt's[1] departure for America as assistant to Professor Clark, who coaxed him over.

Farewell. Best greetings to the Eastwicks and kindly remember,

Your

WÖHLER.

In case you have an opportunity to see Herr Booth at the mint, an old pupil of mine, give him my best greetings. I took care that he received my letter of thanks for the beautiful minerals, which you were kind enough to help unpack. Please also remember me to Gillingham, Magee and Garrigues. Be sure to ask the latter to procure for me a few more specimens of the beautiful graphite on quartz, of which he let me have a small piece, and also to tell me the locality they come from. The graphite without the quartz would be of little interest to me. It is especially important for me to have crystallized graphite, which is said to occur in North America.

WHLR.

I am anxious to hear in your next letter whether the Messrs. Eastwick's business remains unaffected by the great financial crisis.

GÖTTINGEN, 9 *March* 1858.

DEAR GÖSSMANN,—

Permit me to recommend to you most particularly the bearer, Herr Stephani. He has been working in my

[1] Francis E. Engelhardt, Dr. Goessmann's successor at Syracuse.

laboratory this winter and I know him to be an excellent young man. He will tell you what brings him to America and also all that has happened here. Kindly see that he has an opportunity to meet the Messrs. Eastwick, Booth, Garrigues, etc. I hope that you are doing well and that you have received my letter of January 3. Your preliminary communication on the sugar plant was long ago printed in the *Annalen*. My best greetings to the Messrs. Eastwick and other friends. Pardon the shortness of this letter, which I am obliged to write in a hurry, as Stephani is about to depart.

In best friendship,

Your

WÖHLER.

GÖTTINGEN, 31 *Oct.* 1858.

DEAR DOCTOR, —

I am ashamed of myself for not having answered ere this your kind and very interesting letter of August 1. I received it at Karlsruhe, where I had gone from München with Liebig in order to attend the meeting of Naturalists.[1] It proved to be a brilliant success and was attended by nearly all the chemists of Germany. Kuhlmann from Lille, Despretz, Nicklès, Grandeau, Troost from Paris were there. From here besides myself were Limpricht and Wicke (also Dr. Spiegelberg and the troublesome Bialloblotzky).

I have read with pleasure what you say about North America and its people, and also let Liebig read

[1] Deutsche Naturforscher und Aerzte.

your letter. No doubt your views are quite correct, and I am especially pleased to have you express them, for it shows that you know how to adapt yourself to new conditions and take advantage of things intellectual and material. Apart from the fact that by accepting this position you have laid the foundation for a fine career within your sphere of activity, this sojourn will be of the greatest importance in moulding your future life. It would have interested me to hear of your relations with the Eastwicks, how they are progressing, and whether you are satisfied with the conditions. I suppose everything is favourable, since you have never said anything to the contrary.

Doubtless you have long ago learned that your monograph on Sorghum has been printed in Henneberg's *Landwirthsch. Journal*, and also received free copies as well as your honorarium for the same. I have read it with great interest, and have also forwarded a portion of the seeds to Bartling as well as to Dr. Henneberg. The latter has sown them on a piece of land at Weende and the plants are thriving. Yesterday he sent several specimens to the laboratory, where Dr. Schwanert is going to ascertain the amount of sugar they contain. Seeds have also been sent to Henneberg by the Ministerium for experiment. Much attention is being paid to this plant in Germany and France (I believe in Italy, too). Your consignment of seeds and sugar has also reached me, for which accept my heartiest thanks. I have added the little specimens of sugar to the laboratory collection as a present from you, and turned over the beautiful sugar-loaf to my wife. She

could not be persuaded to open the latter until recently, when she was out of sugar. We then had an opportunity to admire its beauty and quality when drinking our coffee, at the same time remembering you gratefully. Geuther secured some seeds for Schleiden: a part of them I kept to plant, the remainder were given to Bartling for our Botanical Garden, and to v. Martius, for the Botanical Garden at München. I hope that at least part of the lot will thrive well at one or the other place.

I was glad to hear that Stephani had arrived and had made your acquaintance. Give him my best greetings. Dr. Bode of Cassel, who could not find a position here, finally left for America on an uncertainty and is, I believe, in Cincinnati. We have not heard anything for a long time from Engelhardt who, as you know, went to America with Prof. Clark. You also write nothing concerning Garrigues, Gillingham, Pugh, Joy, and the others who were here. Has not the latter become a professor in New York? Have you ever made the acquaintance of Mr. Booth, my first American pupil? All this interests me very much. There are now only three Americans working in the laboratory, Messrs. Harris, Little and Stewart, besides two Englishmen. I have accepted only 22 laboratory students this semester, transferring half a dozen to Limpricht in order to avoid the rush in winter. Dr. Geuther still has your position, employing Fabian as an assistant. Limpricht has for assistants Dr. Schwanert, Dr. v. Uslar and Dr. Fittig. I have transferred the 6-hour *Practicum* to the old hospital, where Dr. v. Uslar

resides. This is of great advantage as long as we have no new laboratory. It is still uncertain whether we are to have a new building, as the government has granted only 27,000 thlr., instead of the 38,000 thlr. it will cost according to the plans submitted. In order to design a laboratory which shall be unsurpassed, I have sent Limpricht and the architect Döltz to Wiesbaden, Heidelberg, Stuttgart, Karlsruhe and München, in order to inspect and study the details of all the laboratories in those places. The agricultural laboratory under Wicke is well attended, whereas Boedeker is not popular with the medical students.

I suppose you have an opportunity to read the *Annalen*, so I need not report anything concerning new work. Perhaps you have already received the July number, and know that the remarkable silicium-hydrogen gas may now be prepared chemically in the same manner as phosphorus-hydrogen gas. At present, I am again experimenting with nitrogen-silicium.

Nothing has occurred here that is worth mentioning. A few have died (but no professors — Oesterley, v. Bobers); others are engaged, e. g. Frlein Augusta Baum. I myself have become a grandfather for the second time. All the members of my family are very well, my three oldest daughters having accompanied me on my last journey to the beautiful Bavarian mountains. I have just now spoken to Geuther, who sends his best greetings. He does not know what became of the honorarium for your monograph. He will attend to the matter and have the money sent to your brother, if he has not already received it.

Farewell. Remember me to the Eastwicks and to all the friends, and let me hear from you very soon. When you see Mr. Booth, tell him that a little more osmium-iridium, in which he is so rich, would be very welcome to me. No doubt an opportunity will present itself so it can be sent here.

Cordially your

WÖHLER.

GÖTTINGEN, 12 *March* 1860.

DEAR GÖSSMANN, —

First of all, my hearty thanks for your very full and interesting letter of January 24, for the pieces of graphite and the extraordinarily fine photographs, all of which have made the long voyage successfully and reached me safely. It is a great satisfaction to know that one is not being forgotten by old pupils and friends, and to receive from them so many tokens of attachment, and that you are one of them.

It gives me peculiar pleasure also to know that all goes well with you, that you are contented in your interesting surroundings and that you have so many opportunities to see great and remarkable things, to know the world and to gather experiences which will be of the greatest advantage to you in the future. I envy you your good fortune in having made such a fine voyage.[1] I have also shown your letter to Hofr. Wagner, Waltershausen, Geuther and my own family, and all have read it with great interest. It is striking what an array of new impressions one may receive in

[1] To the West Indies.

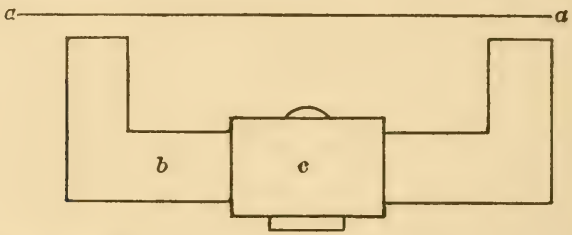
America of which we in old, used-up Europe have no conception. The contents of your letter, as well as its minuteness of detail, proved that you do not think ill of me because I did not write you for such an unpardonably long time. Indeed, it shames me to confess that my last letter was dated 31 October 1858 — if I am not mistaken. The news you sent concerning the former Göttingen Americans gave me much pleasure, and also that you have acted as protector to little Engelhardt, thus probably laying the foundation for his advancement. Only one have you forgotten to mention — Professor Joy of New York, who with his beautiful wife visited us last summer, though we have not had a word from him since. I should be obliged if you would write him a few lines in my name, asking whether he has received the diploma of the Leopold Academy[1] and the silver mirror from Liebig, both having been forwarded at the time to Rinteln according to his directions. I hope he will overcome his dilatoriness and write me himself.

As you have probably seen the *Annalen*, and therefore know already, I shall write nothing about chemical news from our laboratory, except that there is much work being done and that it is well attended. I am aware that you have not yet received this year's March issue. At present I am having Niemann make an investigation of the famous Coca (*Erythroxylon coca* of Peru) and, as far as we have ascertained, it very probably contains an organic base which may be

[1] Academia Caesarea Leopoldino-Carolina Naturae Curiosorum (Kaiserlich-leopoldinisch-carolinische deutsche Akademie der Naturforscher, Halle).

crystallized and which resembles atropin. We have christened it Cocaine. I have received 25 lb. of coca from Vienna, originally from the *Novara's* tour round the world. Probably you are familiar with the new, easy method of producing violet chromium chloride, and know that by melting the same with zinc, metallic chromium in microscopic crystals may easily be obtained.

I do not know whether I have written you that we are going to have a new laboratory here which will, I hope, in construction and equipment surpass all other laboratories. 38,000 thlr. have been granted therefor, it is already under roof, and the finishing of the interior is so far advanced that it will be ready for use next autumn. There will be room for all *Practica* except those of Wicke and Boedeker.



a a is the wall

b the old laboratory

c one-storey centre building with the principal auditorium.

The old laboratory, which will form part of the new wing, is being remodelled and made to harmonize with the rest of the tremendous building by having two

high and many small chimneys. Limpricht, whom I sent with the architect Döltz to inspect all modern laboratories in Germany, has the distinction of planning all the details of the building and the interior equipment. I am sorry to say that he is now going away from here, having received a call to Greifswald as ordinarius with a salary of 1200 thlr. He has also been entrusted with the erection of a new laboratory, a task that will now be easy for him to perform. I could not keep him here longer, although he was appointed ordinarius with a salary of 800 thlr.

I have taken advantage of this occasion to reorganize the laboratory staff. I am conducting the daily *Practicum*, assisted by Dr. Beilstein. Geuther and v. Uslar both have charge of the 24-hour *Practicum*, Dr. Fittig of the 6-hour *Practicum*. All laboratory students have to report to me and are to pay all my fees to the *Quästur*. But the assistants receive from me, in addition to an increase of their fixed salaries, a certain share of the fees.

You probably know already that our good old Hausmann has died, after long suffering, at the age of 76. S. v. Waltershausen has taken his place. Moreover, a young man is to be called — not expensive but excellent — as a specialist in geognosy and palaeontology. Hausmann's beautiful and complete collection (oryctogn. geognost. petrif. technical, metallurgical, antiquarian) is to be sold. You would do the heirs a great favour by finding a trustworthy purchaser. Be sure to let Professor Joy know of this, as perhaps the complete collection would be welcomed in one of your

institutions of learning. They ask 6000 thlr., I believe, but they may be willing to take less. Be sure not to forget this matter.

Good old Berthold is dying, and old Conradi has become so infirm that before long he may follow Hausmann. You have probably known for some time that our celebrated mathematician, Dirichlet, is dead. Riemann has been made ordinarius and member of the Society of Sciences — a prodigious mathematical head. I have been asked to succeed Hausmann as Permanent Secretary of the Society.[1] Wagner's disease of the chest has led him to be placed on the half-retired list, and consequently Professor Meissner, one of our former pupils, has been called as professor of physiology. As a result, the rooms in the Physiological Institute have become so crowded that Boedeker was obliged to transfer his laboratory to the old hospital. As compensation for swallowing the disagreeable pill, he received an increase of salary of 200 thlr. Moreover, I have obtained for him the work of preparing a new edition of Berzelius's *Chemie*, and for Dr. Geuther a new edition of Otto-Graham's *Chemie*. Hanssen has received a call to Berlin and, I am sorry to say, has accepted it. His daughter is engaged to a Prussian officer, and so is Baum's oldest daughter. Both officers were aides to counts and princes studying here. Now I am through gossiping.

Farewell, dear Gössmann, and delight me with more news from you very soon. Best greetings from my family as well as from Limpricht, Wicke and Geuther.

[1] Königliche Gesellschaft der Wissenschaften zu Göttingen.

Remember me to the Eastwicks and all the old Göttinger. There are now only three Americans in the laboratory — Stewart, Parkman and Hart. Whenever you can get hold of some genuine graphite and other minerals, please remember me. My greetings to Booth also.

In best friendship,

Your

WÖHLER.

GÖTTINGEN, 24 *Febr.* 1863.

DEAR GÖSSMANN, —

To-day only a few lines acknowledging the receipt of your letter and to thank you for the interesting communications. The latter I forwarded at once to Oberbergrath Schwarzenberg in Cassel, begging him to comply with your request in regard to the conditions governing the salt manufacturing industry. I did not receive an answer until yesterday (without your letter). He has taken the necessary steps at mining headquarters and has been assured of a reply, which, however, has not yet been received, as delays are not unusual there. As soon as I receive the papers, I shall send them to you and write more fully.

I congratulate you heartily on your marriage and am glad that you are succeeding so well. Nevertheless, I have, when asked about it, proposed you as professor of technical chemistry at the newly established Polytechnic School at Braunschweig, and I know that they are thinking of you seriously. But do not depend too much upon it, as a decision may not be reached for

a year. In the meantime Dr. Seyfert is delivering lectures.

Geuther has received a call to Jena to succeed Lehmann, and has accepted. Although I was unwilling to lose him, nevertheless it was I who proposed him, when asked by the *Curatorium*. More next time.

In best friendship,

Your

WÖHLER.

GÖTTINGEN, 4 *March* 1863.

DEAR GÖSSMANN, —

I hope that you have received through Professor Joy my note of February 24. I have finally obtained from the mining headquarters in Cassel the information concerning the Attendorf Salt Works, and send it to you with the hope that it will meet your expectations.

I had intended to write you more fully on this occasion, but I am so preoccupied just now that I have to be sparing of my time. And yet I should be sorry to delay longer any change in your affairs expected by you. But I shall write you shortly, although, as you very well know, the monotony of our life here affords little occasion to report anything new. I shall then give you first of all a detailed description of our splendid new laboratory, which, to be sure, cost 40,000 thlr. but is, in my opinion, better arranged than any other. There is plenty of room to provide comfortably for at least 80 laboratory students.

Let me call your attention to another thing. Does

not sea-water mother liquor contain chloride of calcium? — now so highly valued, because with Chili saltpetre it may be easily changed into nitrate of potash.

I asked you to pardon this short letter. Write me very soon, for every one of your letters gives me pleasure. I should also like to know whether my consignment through your brother has been delivered to you promptly.

Cordially your

WÖHLER.

GÖTTINGEN, 10 *Jan.* 1866.

DEAR GÖSSMANN, —

I have not heard from you for a long time. But it is my fault, for I believe I owe you an answer to your last letter. You have perhaps heard from Prof. Joy how I am and that all goes well with me. To-day only a few lines and these in great haste.

A former pupil of mine, Herr Meinhard Alsberg, later assistant to Geuther in Jena, wishes me to commend him to you, as he believes that you would have an influential voice in obtaining for him an appointment as assistant in chemistry at a technical school in Philadelphia. He is at present in Philadelphia and intends to apply for the position. So far as I know him, I can strongly recommend him. Moreover, he has already recommended himself through several good investigations, the results of which have been published in the *Annalen*.

This is all I have to say. I hope all goes well with

you. When you write me again, kindly send me your photograph and your wife's.

In old friendship,

Your

WÖHLER.

GÖTTINGEN, 1 *August* 1866.

DEAR GÖSSMANN, —

I am reproaching myself for having left your kind letter of April 14 unanswered for such an unpardonably long time. Be indulgent with me and be assured that it has given me great joy, for it is always a satisfaction to me to receive such proofs of true attachment from my old pupils, especially when they are accompanied by news of their prosperity, as in your case.

It has been a great pleasure to me to receive the photographs of yourself and your wife, thus enriching my collection of pictures of those dear to me. Accept my sincere thanks for them. All the members of my family, who remember you very well, have also been interested to see how you look now, and are glad to have made your wife's acquaintance, at least through the picture; likewise Frau and Fräulein Kreuzhagen, to whom I had to show the pictures. I may here remark that the latter (Anna) is to marry a German physician in London, who formerly studied here.

I must thank you too for your various publications, which I leave to others to read and report to me, not being myself familiar enough with the English language. I am glad to hear that you are contented with your position, and hope and trust that you are

making yourself indispensable to the company, that your future is assured, unless another sphere of usefulness may be open to you in the meanwhile, which might be more congenial to you and offer still greater pecuniary advantages.

To judge by a few utterances in your letter, you are still having an eye to teaching, although you seem to be aware that it is difficult for a foreigner to obtain such a position. Here in Germany there is great demand for such places. I could not hold out any prospects for you at this moment.

While admitting that I am unfamiliar with conditions in America, it surprised me that your company, which produces such a colossal amount of salt, does not start a subsidiary business, e.g. a soda factory or a manufactory utilizing the ingredients of the mother liquor. Yet I am aware you have already thought of this yourself and have your reasons for its impracticability.

I rejoice to hear of your domestic happiness and your fatherhood. When I think that I studied with your father at Marburg and that now his son tells me of his children, I realize from this and many other things how old I am. Yesterday I celebrated my 66 birthday, and '*unser Leben währet 70 Jahr und wenn ist hoch kommt 80.*' Moreover, I am feeling well and can attend to my duties as I have always done. But I cannot attend to the special functions of the strenuous *Practicum* as well as formerly, as every semester seventy or eighty workers use up a quantity of material and tools. Therefore I must leave the principal details

to my four assistants (Professor v. Uslar, Professor Beilstein, Dr. Fittig and Dr. Hübner), and it works quite well. Besides, I have a special assistant to help me in my lectures.

You would find here many things changed and many quite new. Besides the large new laboratory there are fine new conservatories in the Botanical Garden, and in front of the Weender gate (which no longer exists), at the end of the Botanical Garden, is a new, large, very stately hall which cost nearly 100,000 thlr. Adjoining the conservatory a new residence has been built for the director. The enlargement of the library is also being considered, but owing to the sad war now prevailing this project will not be carried out. Of the latter conditions I shall write nothing, they being known to you through the newspapers.

Last month when the king with the whole Hanoverian army and all the munitions of war took refuge here, we were living in a wild, great military camp, daily fearing the outbreak of a battle in our immediate neighbourhood. After the departure of our army Göttingen was occupied by the Prussians. Then came the disastrous battle of Langensalza, followed by the capitulation of our army. The Prussians have also been victorious in the south, where they occupy all of Hesse, Nassau, Darmstadt, Frankfurt and a great part of Bavaria. Their troops are already near or in Würzburg. At present there is an armistice. It is said that all of Hanover, the Electorate of Hesse, and Nassau will be annexed to Prussia. But enough of these painful events.

Hofmann's report of the Exhibition of 1862 [1] has been ready for you for a long time. It affords me pleasure to give you this fine copy, which I have received as a gift from Hofmann himself (with a dedication in his own hand). But it is useless to me, since I do not understand enough English. Now I shall not wait any longer for an opportunity to send it to you, but will do so through Dr. Flügel of Leipzig, commissioner of the Smithsonian Institution. I ought to have done it long ago. Farewell now, dear Doctor. My best remembrances to your wife, and have always a kindly feeling for,

Your truly devoted,

WÖHLER.

My wife and three daughters (the fourth is on a visit at Hanau, the fifth is married in Hanover) send their best greetings and are glad that you still remember them.

Kindly have the enclosed letter forwarded to Esopus. Should there be no post connexion with that place, address it to Columbia College, New York, whence it will be sent to Esopus.

GÖTTINGEN, 17 *Dec.* 1868.

DEAR GÖSSMANN, —

My best thanks for your letter, which was handed to me by Herr Darmstadt, who is now working diligently in our laboratory — at present on boron-nitrogen.

[1] Second International Exhibition, London. On the fly-leaf is written: 'Herrn Hofrath Wöhler hochachtungsvoll u. freundschaftlicht der verf.'; and underneath: 'Herrn Dr. Gössmann zur freundlichen Erinnerung an F. Wöhler.'

The occasion of these lines is your former attendant, Frau Kornrumpf. She told me last summer that you were godfather to her boy, now five years old, requesting me to remind you that thus far you have failed to make a present to your godchild. I had forgotten all about it, until her husband called on me yesterday with the express purpose of again reminding me of it. I hasten, therefore, to let you know the wishes of these evidently very poor people, hoping that you will consider them and send them a little present of money — perhaps a bill of exchange on Engelhardt's mother. These people said they had given her a letter to you some years ago, but had received no answer thereto. In case you feel inclined to be benevolent, you can let them have the money through one of the Americans studying here, for instance, Mr. Carmichael. But should you want to send it directly here, you may address it to me.

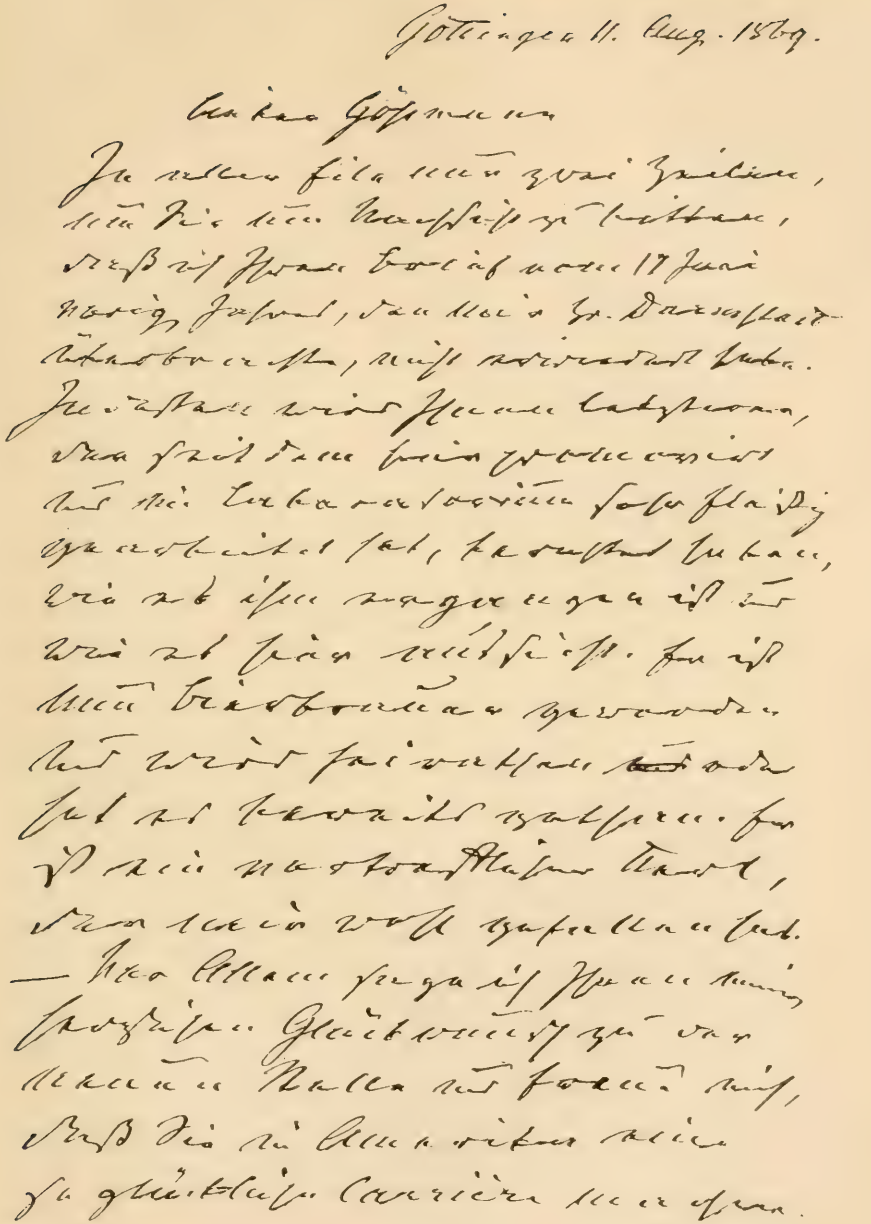
Here everything is going its old course, with some modifications, since we are Prussians. Probably your family have told you of the calamity caused here and also in Fritzlar by the recent terrific storm. During the Mass the roof of the cathedral fell in, killing 22 persons, mostly women. Here, too, houses were unroofed, chimneys thrown down and a great number of the most beautiful old trees were uprooted. Our public squares are in an especially sad condition.

Please remember me to your wife.

In best friendship,

Your

WÖHLER.



A LETTER OF FRIEDRICH WÖHLER (*facsimile*)

Ich sehe wirklich zu beneiden, so viel
Freude hat Ihnen die Reise gebracht und die große
wissenschaftliche Ausbeute ist sicherlich sehr
bedeutend gewesen. Möge es Ihnen ferner wohl
ergehen.

Auf Ihre gütige Anfrage vom
10 ds. bitte ich Sie gütigst mir
Ihre Adresse geben zu wollen. Die Arbeiten
sind inzwischen glücklich gewesen.
Ich bitte Sie mir Ihre Adresse geben,
weil ich Ihnen, sobald sie Ihnen
Ihnen senden wollte, ich bitte
ich mir diesen Sonntag, Montag und
Ihnen wenden.

Der Akademiker ist Dr. Storer
jetzt Amherst, wo ich Ihnen Ihnen
Ihnen vergangen und bitte Ihnen.
Er ist 2 Jahre lang sein Chemie
Professor und hat dann wieder seine
Verbindung Ihnen wünschen
als Assistent zu finden. Ihnen
Ihnen Sie Ihnen Ihnen.

Ihnen Ihnen Ihnen

Ihr

Wöhler.

I congratulate you on the position in Massachusetts, upon which you are going to enter after New Year.

GÖTTINGEN, 11 *Aug.* 1869.

DEAR GÖSSMANN, —

Only a few lines to ask your indulgence for not answering your letter of May 17 of last year, which was delivered to me by Herr Darmstadt. Moreover, this gentleman, who was working very diligently in my laboratory and has since received his degree, has no doubt told you of his success and how things are here. He has now become a brewer, and is going to be married or has already done so. He is an excellent fellow and made a favourable impression on me.

First of all let me heartily congratulate you on your new position. I am delighted that you are having such a successful career in America. You are truly to be envied for having seen so much of the world, and had such great and varied experiences beyond the sea. May you continue to prosper.

I ought to have acknowledged the receipt of the 10 thlr. long ago, for you have thereby made the poor people very happy. I had to give them your address and guessed they wanted to thank you themselves, though I promised to do it for them.

The bearer of this is Dr. Storrs from Amherst, whom I can recommend most particularly to your favour. For two years he has been studying chemistry here and now hopes to find a desirable position, if it be

only as an assistant. Perhaps you can do something for him

In best friendship,

Your

WÖHLER.

GÖTTINGEN, 23 *Nov.* 1875.

DEAR GÖSSMANN, —

You may ascribe it to my conscientiousness in keeping promises, if I take the liberty of troubling you with the request of another. You remember well Frau Kornrumpf, your former attendant, whom you have once before aided with money. For years she has been calling on me from time to time, inquiring whether I have received a new contribution for her. Finally I had to promise to write you, calling your attention to her poverty. I always delayed writing, fearing it would be fruitless to request you for further aid. Whatever I could give her was only a little, since I am contributing a sufficient amount towards the support of the poor. Yesterday she came again, telling me of the distress she and her husband were in, and asked if nothing yet had come for her. From all she (and also recently her husband) told me, and what seemed to me truthful, they must be in great need at present. They do not live here any longer, but at Eldagsen, where the husband is a railway workman. I have now kept my promise, and heartily wish that I may be successful and you will once more send a small contribution to these poor people. Should you be disposed to do so, you may send the money to me.

I hope all continues to go well with you. For a long time I have heard nothing from you. Here things are going on well and we are trying to be good Prussians. Last semester the University was attended by 1080, the present one, by a little over 1000. The laboratory attendance is so great that there is scarcely room left, and an enlargement is being considered. I am now 76 years old, and no longer concern myself with the details of instruction and gave up lecturing some time ago. I have only the general direction of the Institute. Hübner is now the principal one lecturing, having been proposed by me, and appointed professor ordinarius and assistant director of the Institute. v. Uslar is head of the pharmaceutical division. I have in all six assistants, every one of them indispensable. Probably you have heard that Fittig, my former assistant whom you remember well, has become professor at Tübingen. He has now received and accepted a call to Strassburg to succeed Baeyer, who has been called to München as Liebig's successor.

My family are well. My eldest daughter is married to Burgomaster Merkel of this place, has four daughters, the oldest of which is engaged to a physician, so that I have good prospects of becoming a great-grandfather. My youngest daughter is married in London, and has three children. My son, who is an economist at Rödelheim near Frankfurt, lately rejoiced in the birth of a daughter, after the marriage had been without issue for sixteen years. My other three daughters are still single and are very likely to remain so.

A few days ago our botanist Bartling died, 77 years old.

Farewell. Greetings from me to your dear wife, of whom at least I possess a photograph, and kindly remember,

Your truly devoted,

WÖHLER.

My best greetings also to Professor Clark. I shall send you with this letter (under separate cover) a little joke, which is not intended for publication.

GÖTTINGEN, 25 *February* 1876.

DEAR COLLEAGUE GÖSSMANN, —

A thousand thanks for your exhaustive, interesting letter, the extraordinarily beautiful photographs and the money for the Kornrumpfs.

While I was reading in the first the sketch of your varied life in America, I thought of the remarkable occurrences in this world, how I could not foresee 55 years ago, when I began my studies at Marburg, that my fellow-student Gössmann from Fritzlar, who played the flute so well and serenaded the belles of Marburg so often, while I held the lantern, should one day have a son, who would become one of my dearest pupils, and that the latter would now be living in America, for 19 years, in full activity and laying the foundation for a most happy existence. You can imagine how interesting it was to me to have such a vivid picture of your family. The same is true of the picture of Clark, to whom please express my hearty thanks. I consider him also as one of my most lovable pupils,

especially since he and poor Manross[1] were the first Americans who worked under me here. Only one had been here earlier, Mr. Booth, now in Philadelphia; but at that time I was still at Cassel. One of the half dozen Americans, who are working again in the laboratory this winter, says he heard of Clark's going to Japan.

The money for the Kornrumpfs, amounting to 12 thlr. 14 gr., was paid to me from Köln. At first I had difficulty in finding the people, since they are no longer here, but, as I afterwards learned, live at Hardegsen. The poor devil of a husband, who finally came to me for the money, was almost moved to tears. He evidently did not expect so large a sum. He wished to write you himself in order to thank you. I told him I would do it for him.

Now I have been interrupted by visitors waiting to see me, and it is high time for this letter to be posted, so that it shall arrive in due season to-morrow for the steamer at Bremen. Farewell. Remember me to your wife and greet all who remember me, including Professor Shepard.

In best friendship,

Your WÖHLER.

Perhaps an opportunity will occur to you to have a translation of the enclosed announcement printed in an American mathematical journal or newspaper. If not, then send it to the leading bookseller in New York.

[1] Newton Spaulding Manross (Yale, 1850; Ph.D. Göttingen, 1852) of Bristol, Conn., and William S. Clark were fellow-students in Wöhler's Laboratory. In 1861–62, during Clark's absence at the front in the Civil War, Manross taught his classes at Amherst College. At the end of the year he raised a company of volunteers at Bristol, was made captain, and fell at Antietam leading his men.

APPENDIX

ABBREVIATIONS OF FOREIGN PUBLICATIONS

Amtl. Ber. deutsch. Naturf. u. Aerzte.	Amtlicher Bericht über die Versammlung deutscher Naturforscher und Aerzte.
Ann. Chem. Pharm.	Annalen der Chemie und Pharmacie, Leipzig und Heidelberg. Wöhler, Liebig und Kopp.
Ann. chim. phys.	Annales de chimie et de physique, Paris. Gay-Lussac, Arago, Chevreul, Dumas, Pelouze, Boussingault, Regnault, de Senarmont et Wurtz.
Centr. Agrik.-Chem.	Biedermanns Central-Blatt für Agrikulturchemie und rationellen Landwirthschafts-Betrieb, Leipzig.
Chem. Centr.	Chemisches Central-Blatt, Leipzig.
Chem.-Pharm. Centr.	Chemisch - Pharmaceutisches Central-Blatt, Leipzig.
Chem. Gaz.	Chemical Gazette, London. W. Francis.
Chem. News	Chemical News, London. W. Crookes.
Comptes rendus de l'Acad. des Sci.	Comptes rendus de l'Académie des Sciences, Paris.
Journ. Chem. Soc.	Journal of the Chemical Society of London.
Journ. de pharm.	Journal de pharmacie et des sciences accessoires, Paris.
Journ. für Landwirthschaft	Journal für Landwirthschaft, Göttingen-Weende. W. Henneberg.

Journ. prakt. Chem......Journal für praktische Chemie, Leipzig. O. L. Erdmann und G. Werther.

Oesterreich. Landw. Wochenbl......Oesterreichisches landwirthschaftliches Wochenblatt, Wien.

Pharm. Journ. Trans......Pharmaceutical Journal and Transactions, London. Jacob Bell.

Phil. Mag......London, Edinburgh, and Dublin Philosophical Magazine. Sir David Brewster, Richard Taylor, Sir Robert Kane, William Francis, John Tyndall.

Polytech. Journ......Polytechnisches Journal, Augsburg.

Quart. Journ. Chem. Soc......Quarterly Journal of the Chemical Society of London.

Zeit. anal. Chem......Zeitschrift für analytische Chemie, Wiesbaden. C. R. Fresenius.

LIST OF THE PUBLISHED WRITINGS OF CHARLES ANTHONY GOESSMANN [1]

1853

1. Ueber die Bestandtheile der Canthariden. Inaugural-Dissertation zur Erlangung der philosophischen Doctorwürde von K. A. Goessmann aus Fritzlar. Göttingen, Druck der Univ.-Buchdruckerei von E. A. Huth. 1853. 8vo, SS. 38.
2. Ueber die Natur des Fettes der Canthariden. *Ann. Chem. Pharm.* Bd. LXXXVI. 1853, S. 317–330; *Journ. de pharm.* t. XXIV. 1853, pp. 378, 379; *Chem.-Pharm. Centr.* 1854, S. 49, '50; *Chem. Gaz.* vol. XII. 1854, p. 92.

1854

3. Ueber die Arachinsäure. *Ann. Chem. Pharm.* Bd. LXXXIX. 1854, S. 1–11; *Journ. prakt. Chem.* Bd. LXI. 1854, S. 236–238; *Polytech. Journ.* Bd. CXXXI. 1854, S. 156, 157; *Chem.-Pharm. Centr.* 1854, S. 50, 51; *Ann. chim. phys.* t. XLVI. 1856, pp. 230–232; *Quart. Journ. Chem. Soc.* vol. VIII. 1856, p. 279; Sur l'acide de l'huile d'Arachide. *Journ. de pharm.* t. XXV. 1854, pp. 158, 159.
4. Ueber die Margarinsäure im Fette der Canthariden. *Ann. Chem. Pharm.* Bd. LXXXIX. 1854, S. 123–125; *Journ. prakt. Chem.* Bd. LXI. 1854, S. 238, 239; *Chem.-Pharm. Centr.* 1854, S. 50; *Chem. Gaz.* vol. XII. 1854, p. 92.
5. Ueber die Bestandtheile der Cacaobutter (gemeinsam mit C. SPECHT). *Ann. Chem. Pharm.* Bd. XC. 1854, S. 126–128; *Journ. prakt. Chem.* Bd. LXII. 1854, S. 310; *Chem.-Pharm. Centr.* 1854, S. 607; *Journ. de pharm.* t. XXVI. 1854, pp. 238, 239; *Chem. Gaz.* vol. XII. 1854, pp. 306–308.
6. Neue Methode zur Darstellung der Benzoglycolsäure. *Ann. Chem. Pharm.* Bd. XC. 1854, S. 181–184; *Journ. prakt. Chem.*

[1] A few short papers, usually extracts from some of the longer ones, appear more than once in this list. Goessmann was in the habit of sending the same paper, with only a few changes, to several publications.

Bd. LXIII. 1854, S. 88, 89; *Chem.-Pharm. Centr.* 1854, S. 672; *Chem. Gaz.* vol. XII. 1854, pp. 310–312; *Journ. de pharm.* t. XXVII. 1855, pp. 397–399.

7. Verwandlung des Thialdins in Leucin. *Ann. Chem. Pharm.* Bd. XC. 1854, S. 184, 185; *Journ. prakt. Chem.* Bd. LXIII. 1854, S. 190; *Chem.-Pharm. Centr.* 1854, S. 672; *Journ. de pharm.* t. XXVI. 1854, p. 156; *Chem. Gaz.* vol. XII. 1854, pp. 188, 325, 326: — Lettre de M. WÖHLER à M. DUMAS, *Comptes rendus de l'Acad. des Sci.* t. XXXVIII. 1854, pp. 555–557.
8. Ueber die Bildungs-und Bereitungsweise des Aethylamins. *Ann. Chem. Pharm.* Bd. XCI. 1854, S. 122–125; *Chem.-Pharm. Centr.* 1854, S. 751, 752; *Ann. chim. phys.* t. XLII. 1854, p. 246; *Journ. prakt. Chem.* Bd. LXV. 1855, S. 244; *Quart. Journ. Chem. Soc.* vol. VIII. 1856, pp. 161–163.
9. Beitrag zur Kenntniss des Leucins. *Ann. Chem. Pharm.* Bd. XCI. 1854, S. 129–138; *Journ. prakt. Chem.* Bd. LXIII. 1854, S. 375–378; *Chem.-Pharm. Centr.* 1854, S. 801–803; *Ann. chim. phys.* t. XLII. 1854, p. 499; *Chem. Gaz.* vol. XII. 1854, pp. 467–469; *Journ. de pharm.* t. XXVII. 1855, pp. 73–75.
10. Ueber Leucin und Essigsäure-Aldehyd. Vortrag bei der Versammlung deutscher Naturforscher und Aerzte in Göttingen, September 1854. *Amtl. Ber. deutsch. Naturf. u. Aerzte*, 1854 (1860), S. 50.

1855

11. Ueber eine neue Bildung des Amarins und Lophins. *Ann. Chem. Pharm.* Bd. XCIII. 1855, S. 329–333; *Journ. prakt. Chem.* Bd. LXV. 1855, S. 245–247; *Chem.-Pharm. Centr.* 1855, S. 266; *Ann. chim. phys.* t. XLV. 1855, pp. 123, 124; *Chem. Gaz.* vol. XIII. 1855, pp. 144–146; *Quart. Journ. Chem. Soc.* vol. VIII. 1856, pp. 161–163.
12. Ueber die Hypogäsäure, eine neue Fettsäure im Erdnussöl (gemeinsam mit H. SCHEVEN). *Ann. Chem. Pharm.* Bd. XCIV. 1855, S. 230–235; *Journ. prakt. Chem.* Bd. LXVI. 1855, S. 83–85; *Chem.-Pharm. Centr.* 1855, S. 468, 469; *Chem. Gaz.* vol. XIII. 1855, pp. 209, 210; *Ann. chim. phys.* t. XLVI. 1856, pp. 230–232; *Journ. de pharm.* t. XXIX. 1856, pp. 238, 239; *Quart. Journ. Chem. Soc.* vol. VIII. 1856, pp. 279–282.

1856

13. Ueber die Verbindungen der Arachinsäure (gemeinsam mit H. SCHEVEN). *Ann. Chem. Pharm.* Bd. XCVII. 1856, S. 257–

265; *Journ. prakt. Chem.* Bd. LXVIII. 1856, S. 179–183; *Chem. Centr.* 1856, S. 309–312; *Ann. chim. phys.* t. XLVII. 1856, pp. 382–384 (BERTHELOT) *ibid.* pp. 355, 356; *Chem. Gaz.* vol. XIV. 1856, pp. 181–185.

14. Zur Kenntniss des Lophins (gemeinsam mit E. ATKINSON). *Ann. Chem. Pharm.* Bd. XCVII. 1856, S. 283–294; *Journ. prakt. Chem.* Bd. LXVIII. 1856, S. 154–157; *Chem. Centr.* 1856, S. 420–422; *Quart. Journ. Chem. Soc.* vol. IX. 1857, pp. 220–226; *Phil. Mag.* (4) vol. XII. 1856, p. 55.
15. Darstellung des Cumarins. *Ann. Chem. Pharm.* Bd. XCVIII. 1856, S. 66; *Journ. prakt. Chem.* Bd. LXVIII. 1856, S. 192; *Chem. Centr.* 1856, S. 478; *Chem. Gaz.* vol. XIV. 1856, pp. 210, 211.
16. Ueber einige Verwandlungsproducte der Hypogäsäure (gemeinsam mit G. C. CALDWELL). *Ann. Chem. Pharm.* Bd. XCIX. 1856, S. 305–314; *Chem. Centr.* 1856, S. 892, 893; *Journ. prakt. Chem.* Bd. LXX. 1857, S. 79–81; *Ann. chim. phys.* t. XLIX. 1857, pp. 111, 112; *Chem. Gaz.* vol. XV. 1857, pp. 23, 24; *Phil. Mag.* (4) vol. XIII. 1857, p. 185.
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347. Analyses of Manurial Substances and Licensed Fertilizers. *Bull. Hatch Expt. Stat. Mass.* No. 92. November, 1903, pp. 36.

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355. Analyses of Manurial Substances and Licensed Fertilizers; Market Values of Fertilizing Ingredients. *Bull. Hatch Expt. Stat. Mass.* No. 104. July, 1905, pp. 28.

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359. Analyses of Manurial Substances and Licensed Fertilizers; Market Values of Fertilizing Ingredients. *Bull. Hatch Expt. Stat. Mass.* No. 111. July, 1906, pp. 28.

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NOTICES OF CHARLES ANTHONY GOESSMANN

Letter of Friedrich Wöhler to Justus Liebig, 16 March 1857. *Aus Justus Liebig's und Friedrich Wöhler's Briefwechsel 1829–1873.* Braunschweig 1888. Band II. S. 39, 40.[1]

The Amherst Record of May 21, 1868.

Courier and Union, Syracuse, N.Y., May 28, 1868.

Central Demokrat, Syracuse, den 26ten Dezember 1868.

Agriculture of Massachusetts for 1868–69, pp. 23–25, 118, 119, 122, 123. By William S. Clark and Louis Agassiz.

Address on American Contributions to Chemistry, at the meeting to celebrate the Centennial of Chemistry, at Northumberland, Penn., July 31, 1874. By Benjamin Silliman. *American Chemist*, vol. v. 1874, pp. 112, 113.

Sixth Annual Report of the Trustees of the Massachusetts Agricultural College, January 1869, p. 7. By William S. Clark.

The Catholic World Magazine, vol. LXVI. March 1898, pp. 856–858, with portrait.

Poggendorff's Biographisch-Literarisches Handwörterbuch zur Geschichte der exacten Wissenschaften, Bd. III. 1898, p. 529. By H. Carrington Bolton.

A Sketch of Charles A. Goessmann. By Charles S. Walker. *The Springfield Union* of June 30, 1900, p. 1, with portrait.

Experiment Station Record, Washington, vol. XVIII. 1907, pp. 1101–1104. By Edwin W. Allen.

Testimonial to Professor Goessmann, June 18, 1907. Address by Charles Wellington. *Forty-fifth Annual Report of the Massachusetts Agricultural College*, January 1908, pp. 56–60.

[1] 'As a teacher Wöhler ranks with Liebig and Berzelius. In a sense he was the greatest of the three. Berzelius never had the opportunity to teach large numbers of students in his laboratory; and Liebig lacked the many-sidedness so characteristic of the Göttingen laboratory as long as it really was under Wöhler's personal direction. One student might wish to work on organic chemistry, another on minerals, a third on metallurgy, a fourth on rare elements; let them all go to Wöhler, and all, as well as the fifth or sixth, would find themselves in the right place.' (William Dittmar.)

A Tribute. By William H. Bowker. *College and Alumni News*, vol. v. 1907, pp. 47–49, with portrait.

Forty-fifth Annual Report of the Massachusetts Agricultural College, January 1908, pp. 95–98 (*passim*), 113–115. By William P. Brooks.

Twentieth Annual Report of the Massachusetts Agricultural Experiment Station, January 1908, pp. 5–9. By William P. Brooks.

The Index of the Class of 1909. Dedicated to Charles Anthony Goessmann, with a tribute by Charles Wellington. (Vol. XXXIX. pp. 8–11, with portrait.)

The Springfield Republican of September 2, 1910, p. 11, with portrait.

The Springfield Union of September 2, 1910.

The Amherst Record of September 7, 1910.

Action of the Board of Trustees of the Massachusetts Agricultural College. *The College Signal*, vol. XXI. 1910, pp. 5, 6. By William H. Bowker.

Memorial Service. Addresses by Kenyon L. Butterfield, Charles Wellington, Winthrop E. Stone and Charles F. Chandler. *The College Signal*, vol. XXI. 1910, pp. 1, 4–7; *The Springfield Union*, October 12, 1910; *The Springfield Republican*, October 13, 1910.

Nature, London, vol. LXXXIV. 1910, p. 370.

Experiment Station Record, Washington, vol. XXIII. 1910, pp. 401, 402. By Edwin W. Allen.

The American Chemical Journal, vol. XLIV. 1910, pp. 475–477. By Joseph S. Chamberlain.

Proceedings of the American Chemical Society, vol. XXXII. 1910, pp. 131, 132. By Homer J. Wheeler.

Southern Ruralist, December 1, 1910, p. 16. By Horace E. Stockbridge.

Forty-eighth Annual Report of the Massachusetts Agricultural College, part 1, January 1911, pp. 14, 15. By Kenyon L. Butterfield.

Twenty-third Annual Report of the Massachusetts Agricultural Experiment Station, January 1911, pp. 13, 14, 80–85, with portrait. By Joseph B. Lindsey.

Sketch of Dr. Goessmann. *McEvoy Magazine*, January 1911, pp. 239–242, 286. By Thomas J. McEvoy.

Historical Records and Studies of the United States Catholic Historical Society, vol. VI. part 1, February 1911, pp. 131–159, with portrait. By Frederick Tuckerman.

CHRONOLOGY

1827. Born at Naumburg, Electorate of Hesse-Cassel, Germany, June 13.

1832–36. Attended public and private schools in Naumburg.

1836–42. At the Latin School in Fritzlar.

1842–46. Apprenticed to his cousin Louis Elith, apothecary in Gudensberg, Hesse-Cassel, 28 March 1842 to March 1846.

1846. Passed examination as assistant in pharmacy, before the Kurf: Hess: Ober-Medizinal-Kollegium zu Kassel, February 24.

1846–47. Assistant to Julius Post, University Apothecary, Göttingen, April 1846 to April 1847.

1847–48. Assistant to Paul Dückeissen (Engel-Apotheke), Mainz, Grand Duchy of Hesse, April 1847 to October 1848.

1848. Received as a member of the Pius-Verein für religiöse Freiheit zu Mainz, April 5.

1848–50. Assistant to Th. Jacobi, apothecary, Fulda, Hesse-Cassel, 1 October 1848 to 31 March 1850.

1850. Entered the University of Göttingen at Easter, 27 April 1850, matriculating in the philosophical faculty as a student of pharmacy — Joh. Karl Ludw. Gieseler, *Prorector.*

1851. Appointed assistant in analytical chemistry, under Professor Staedeler, October 18.

1852. Passed examination as apothecary in Hessen-Kassel (Kurhessen), before the Kurf: Hess: Ober-Medizinal-Kollegium, March 23.

1852. Appointed second assistant in the Chemical Laboratory, Göttingen, June 8.

1852. Presented a dissertation, *Ueber die Bestandtheile der Canthariden*, and on December 27 received the degree of Doctor of Philosophy.

1853. Inaugural-Dissertation printed, a synopsis of which, entitled *Ueber die Natur des Fettes der Canthariden*, appeared the same year in Wöhler, Liebig und Kopp's *Annalen der Chemie und Pharmacie.*

1854. Published the results of his research on the conversion of thialdine into leucin. *Habilitationsschrift.*

1854. Read a paper before the meeting of German Naturalists and Physicians at Göttingen, in September, entitled *Ueber Leucin und Essigsäure-Aldehyd.*

1855. Appointed *Privatdocent* in chemistry and pharmacy for one year, in the Philosophical Faculty, Göttingen, February 24.

1855. Succeeded Heinrich Limpricht as first assistant in the Chemical Laboratory, Göttingen.

1855. Elected a corresponding member of the Physico-Medical Society of Erlangen, Bavaria, May 19.

1856. Appointed *Privatdocent* in the Philosophical Faculty of the University of Göttingen, *venia legendi*, January 29.

1856. Attended the annual meeting of the German Naturalists and Physicians at Vienna, September 16–24.

1857. Granted a three years' leave of absence by the University, at the close of the winter semester, in order to study the chemical industries of France, England, and the United States.

1857. Sailed from Bremen for New York, May 12.

1857. First paper on sugar. Published in Wöhler und Liebig's *Annalen.*

1857–60. Chemist and General Superintendent of the Eastwick Brothers' Steam Sugar Refinery, Philadelphia. Resigned December 1, 1860.

1860. Visited Cuba for the purpose of studying the agricultural industries of the West Indies, especially the manufacture and refining of sugar. 3 December 1860 to 21 March 1861.

1861–68. Chemist to the Salt Company of Onondaga, Syracuse, New York, April 1861 to December 1868.

1861. Elected an honorary member of the Chemical Society of Union College, October 21.

1862. Address on the *Nature of the Chinese Sugar-cane*, delivered before the New York State Agricultural Society, in February.

1862. Married October 22, at Syracuse, New York, Mary Anna Clara Kinny.

1862. Visited Saginaw, Michigan, in October, to examine the brines and saline deposits.

1862. First paper on brines and salines.

1862–64. Taught Chemistry at the Rensselaer Polytechnic Institute at Troy, New York. Elected Professor of Chemistry and Physics at the Institute, July 9, 1863.

1863. Elected a corresponding and honorary member of the New York State Agricultural Society, in January. Date of certificate, February 12.

1863. Elected a corresponding member of the Buffalo Society of Natural Sciences, May 7.

1865. Elected a corresponding member of the New York Academy of Sciences (formerly the Lyceum of Natural History), October 2.

1866. Appointed Consulting Correspondent of the American Bureau of Mines, New York, March 10.

1866. Commissioned by the Board of Experts of the American Bureau of Mines to visit Louisiana and investigate the rock-salt deposit of Petite Anse Island, New Iberia, on Vermilion Bay, October 30.

1867. Made two visits to Canada, in June and December respectively, for the purpose of ascertaining the extent of the saline resources and the quality of the brines, especially at Goderich.

1868. Elected Professor of Chemistry at the Massachusetts Agricultural College, May 12, and entered upon his duties in December.

1868. Admitted as a citizen of the United States of America, October 23.

1869. Elected a member of the American Association for the Advancement of Science, Salem meeting, August 18.

1869. Address on the *Chemistry of Common Salt,* delivered before the National Academy of Sciences, Northampton session, August 31.

1869. Address on *Salt and its Uses in Agriculture,* delivered before the Massachusetts State Board of Agriculture, December 7. Goessmann's earliest paper on fertilization.

1870–74. Experiments on the cultivation of the sugar beet.

1873. Appointed Chemist of the State Board of Agriculture of Massachusetts, February 4.

1873. Enactment of the First Fertilizer Law in the United States, passed and approved May 26. Of this law Goessmann was the prime author.

1873–1910. *Ex officio* a member of the State Board of Agriculture and State Inspector of Fertilizers, May 26, 1873.

1874. Member of the General Committee of American Chemists, chosen to commemorate the one hundredth anniversary of the discovery of Oxygen by Joseph Priestley.

1874–80. Systematic investigation of the chemical and physical condition of the salt marshes of the State.

1875. Elected a Fellow of the American Association for the Advancement of Science, Detroit meeting, August 17.

1876. Original member of the American Chemical Society and elected Vice-President, November 2.

1880. Elected State Agricultural Chemist of North Carolina and Director of the Experiment Station at Chapel Hill, March 2.

1880. Original member of the Society for the Promotion of Agricultural Science, August 24.

1880–81. Chairman of the Association of Agricultural Chemists — later the Association of Official Agricultural Chemists of the United States.

1881–82. Member of the Committee appointed by the National Academy of Sciences to investigate the Scientific and Economic Relations of the Sorghum-sugar Industry in the United States.

1881–82. Vice-President of the American Chemical Society.

1882. Elected a member of the Virginia Historical Society, June 16.

1882–95. Director and Chemist of the Massachusetts Agricultural Experiment Station. Appointed November 9, 1882.

1883. Member of the American Metrological Society.

1883–1904. Analyst to the State Board of Health of Massachusetts.

1885. Delegate to the First Convention of Agricultural Colleges and Experiment Stations, at Washington, July 8 and 9.

1886. Elected Chemist to the Bay State Agricultural Society, March 1.

1887. President of the American Chemical Society. Elected December 3, 1886.

1888–95. Member of the Board of Control of the Massachusetts Agricultural Experiment Station.

1889. Elected a corresponding member of the Massachusetts Horticultural Society, April 6.

1889. Degree of Doctor of Laws conferred by Amherst College, July 2.

1889. Foreign member of the Committee on Plant Food, Allgemeine land- und forstwirthschaftliche Ausstellung, Wien 1890.

1892. Appointed a member of the Advisory Council on Chemistry of the World's Congress Auxiliary of the Columbian Exposition, December 12.

1892–95. Treasurer of the Massachusetts Agricultural Experiment Station.

1894. Member of the American Lavoisier Committee for the erection in Paris of a monument to Antoine-Laurent Lavoisier.

1895. Appointed Honorary Director of the Experiment Station, Massachusetts Agricultural College, April 16.

1898. Elected a member of the American Statistical Association, January 21.

1899–1900. In August 1899 Dr. Goessmann, accompanied by his family, revisited the Fatherland after an absence of forty years, remaining abroad until the following June. He went also as an honorary representative of the United States Department of Agriculture to the German Empire, and as a delegate of the American Chemical Society to the unveiling of the statue of Antoine-Laurent Lavoisier in Paris.

1899–1910. Member of the Council of the American Chemical Society.

1900. Elected a member of the Washington Academy of Sciences, January 9.

1900. Member of the American Academy of Political and Social Science.

1907. Resigned the Professorship of Chemistry in June, retiring on a pension from the Carnegie Foundation.

1907. Presented by his pupils with a stained-glass window, June 17, commemorative of forty years of service at the Massachusetts Agricultural College.

1907. Resigned as Chemist of the Experiment Station, Massachusetts Agricultural College, and appointed Consulting Chemical Expert, July 1.

1908. Professor of Chemistry, *Emeritus*, June 16.

1910. Portrait of Dr. Goessmann presented to the College by the Alumni, June 21.

1910. Died at Amherst, September 1.

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visits Cuba, 20;
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visits Michigan, 22;
visits Louisiana, 22;
visits Canada, 22–23;
elected professor of chemistry and physics at the Rensselaer Polytechnic Institute, Troy, 25;
marriage, 26;
elected professor of chemistry at the Massachusetts Agricultural College, 28;
appointed chemist of the Massachusetts Board of Agriculture, 35;
appointed State Inspector of Fertilizers, 35;
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